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UNITED STATES CIVIL-SERVICE EXAMINATIONS

The United States Civil-Service Commission announces open competitive examinations for assistant scientific aid, $1500; junior scientific aid, $1320, and under laboratory apprentice, $1140.

Applications for these positions must be on file with the Civil-Service Commission at Washington, D. C., not later than April 30th. The date for assembling of competitors will be stated on their admission cards and will be about ten days after the close of receipt of applications.

The examinations are to fill vacancies in the Departmental Service, Washington, D. C., including the Bureau of Standards, and vacancies in positions requiring similar qualifications.

The entrance salaries in the District of Columbia are indicated above. A probationary period of six months is required; advancement after that depends upon individual efficiency, increased usefulness, and the occurrence of vacancies in higher positions. For appointment in the field service the entrance salaries will be approximately the same.

For the position of assistant scientific aid examination will be given in the following optional subjects: Advanced general physics, ceramics, chemical engineering, civil and mechanical engineering, electrical engineering, paper technology, physical metallurgy, physics and chemistry, and textile technology.

For the positions of junior scientific aid and under laboratory apprentice separate registers will be established of those qualified in physics, those qualified in chemistry, and those qualified in both physics and chemistry.

Full information and application blanks may be obtained from the United States Civil-Service Commission, Washington, D. C., or the secretary of the board of U. S. civil-service examiners at the post-office or customhouse in any city.

The United States Civil-Service Commission announces open competitive examinations for mechanical laboratorian and metallurgical laboratorian.

Applications for mechanical and metallurgical laboratorians must be on file with the Civil-Service Commission at Washington, D. C., not later than April 30th. The date for assembling of competitors will be stated on their admission cards and will be about ten days after the close of receipt of applications.

The examinations are to fill vacancies in the United States Naval Academy, Annapolis, Md., at $4.32 a day, and vacancies occurring in the Federal classified field service throughout the United States in positions requiring similar qualifications, at approximately the same rate of pay.

The duties are to assist in physical, chemical, and engineering laboratories; to set up chemical and physical apparatus, make repairs, and conduct experimental work; assist in making physical tests, heat treatment, and metallographic examination of metals; determination of transformation temperatures; calibration of instruments, such as pyrometers; calculation and plotting of results of tests; and making sketches and drawings of apparatus.

Competitors will be rated on practical questions, and their education, training, and experience.

Full information and application blanks may be obtained from the United States Civil-Service Commission, Washington, D. C., or the secretary of the board of U. S. civil-service examiners at the post-office or customhouse in any city.

ROBERT WILHELM BUNSEN

EDITOR'S OUTLOOK

AS THESE words are written the Richmond meeting of the American Chemical Society is still in prospect. Hence we have as yet no definite knowledge of what the discussion on "Coöperation of Local Sections of the A. C. S. with Teachers of Chemistry," scheduled for the Thursday afternoon session of the Division of Chemical Education, may bring forth. We feel, however, that the inclusion of such a topic was a particularly happy inspiration on the part of the program makers.

Local Sections and Chemistry Students

A number of local sections have for some time engaged in various coöperative enterprises with the educational forces in their territories. Several projects have been described in THIS JOURNAL. This month we publish a committee report to the Northeastern Section which constitutes the basis for the system of affiliated Student Chapters in operation there.[1]

No doubt the most effective type of coöperative activity in any particular case must be determined to a considerable extent by local conditions. It seems that it would be both possible and desirable, however, for every local section to undertake some active encouragement of chemical education within its area.

Such encouragement is particularly valuable when it provides, as in the case of the Northeastern Section, for actual association between prospective chemists and established members of the profession. The student thus early learns the benefits to be derived from affiliation with the American Chemical Society and begins to make contacts which will be helpful to him throughout his career. The Society likewise gains, for it thereby continually draws into its membership the rising generation of chemists.

PLANS for the Eleventh Exposition of Chemical Industries which is to open its doors on September 26th are already rapidly maturing. These expositions offer a splendid educational opportunity to all students and teachers of chemistry within visiting distance. The exhibits themselves constitute a survey of advanced practice and equipment in almost every major line of chemical industry and the company representatives in charge of displays are always willing and eager to make supplementary explanations.

Exposition of Chemical Industries

Among this year's exhibits of special interest may be mentioned that of the National Safety Council. Particular attention will be devoted

[1] See p. 524.

to a recent investigation into the hazards of benzol and to an investigation now under way as to the hazards of spray painting. Various other safety exhibits will be grouped around that of the Council.

Another feature of interest will be the exhibit of new metal alloys to be shown for the first time.

The Students' Courses which have met with such gratifying success in the past will be continued. A number of prominent experts have already agreed to lecture before these groups and further negotiations are in progress. As heretofore, students may arrange with their institutions to receive scholastic credit for the work done at the exposition.

Professor W. T. Read of the Texas Technological College, Lubbock, Texas, who arranged the previous courses is again in charge and is sparing no effort in the preparation of a program to exceed all past performances. That the lectures presented may best meet the needs of those for whom they are designed, Prof. Read is particularly desirous of suggestions as to subjects which should be stressed. Communications from institutions where a number of students are planning to attend the exposition will be especially welcomed.

Principle and Practice

ONE of the principles extolled by the educational evangelists and theoretically accepted by teachers generally is that the educational process stands approved or condemned in the extent to which the student is guided to self-activity and incited to creative thought. We have no quarrel with this principle. Like most general principles, however, it cannot be applied to specific cases without the exercise of some thought and ingenuity. Any industrial chemist or engineer can assure you that the transition from theory to practice is not accomplished by a simple twist of the wrist. We are always glad, therefore, to be able to present to our readers some concrete suggestions concerning the application of this or other principles. Professor Taylor's paper on "A Second-Year Chemistry Course for Colleges" attempts just that.

It must be confessed that the concrete suggestion is always at a disadvantage. It comes out into the open and lays itself bare to criticism. But though it runs the risk of error it also gains the possibility of accomplishment. We believe that more papers of this type are needed and would be welcomed by long-suffering teachers.

ROBERT WILHELM BUNSEN

RALPH E. OESPER, UNIVERSITY OF CINCINNATI, CINCINNATI, OHIO

One of the most colorful figures in the history of chemistry is Robert Bunsen. His greatness as an investigator is sufficient to ensure his everlasting fame, and the efficiency of his teaching sufficed to make him the idol of his students. However, the personal characteristics of even the great men of science are soon forgotten, and the present writer esteems it a great privilege to have heard something about Bunsen from several of those who worked under him at Heidelberg. The laboratory has been remodeled since his retirement in 1889 and not one piece of his apparatus is to be found there. (Some of the original burners, pumps, gas analysis apparatus, etc., are preserved in the Deutsches Museum in Munich.) Though the physical evidences of his long residence in Heidelberg are limited to the admirable bronze statue, the "*Wohnung*" adjoining the "*Institut*" and his grave, Bunsen's memory is still cherished by the older townspeople who count it an honor to have seen and sometimes conversed with this simple but great man. The plain stone which marks his grave bears nothing but his name, in striking contrast with many of the memorials in the professors' section of the cemetery which detail complete titles, degrees, and orders of the departed.

"What need'st thou such weak witness of thy name?
Thou in our wonderment and astonishment
Hast built thyself a live-long monument."

Bunsen was almost six feet in height, powerfully built, and capable of working incessantly without showing fatigue. He was a most skilful manipulator, especially dextrous as a glassworker and he demanded that his students emulate him in the construction of their own apparatus. Striving for perfection was a passion with him, and he insisted on attention to details even at the cost of frequent repetition of a prolonged exercise. He set a fine example by persisting at a difficult task until he had either succeeded or had convinced himself that the undertaking was beyond his ability. There was never the least doubt as to who was the master mind and worker in his laboratory. He spent the whole day there, actually working with the students. He carried the minutest detail of each problem in his mind, was usually surrounded by half a dozen men, each waiting to be shown some trick of technic, but all certain that useful hints would be absorbed in the meanwhile. His enthusiasm was contagious and a spirit of careful and persistent endeavor pervaded the whole group. He did not drive the students; his attitude was always one of friendly dignity and a quiet remark, "*Mein Gott, wie könnten Sie so was tun?*" was sufficient remonstrance for even an exceptionally stupid performance.

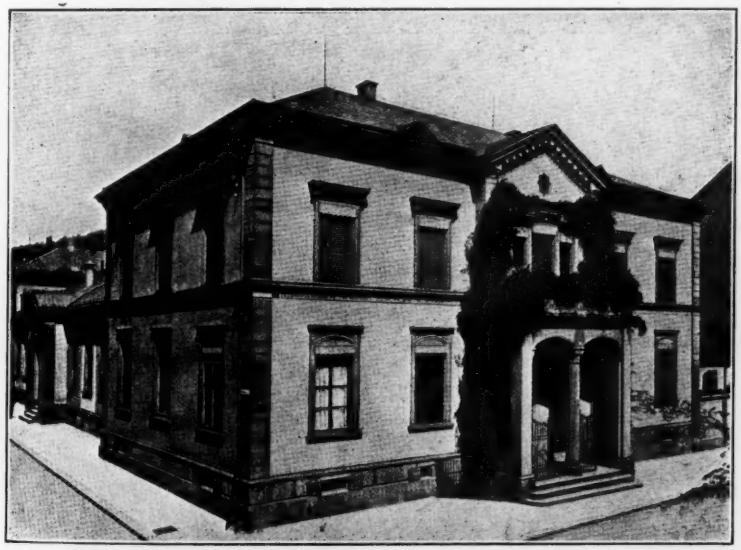
He never seemed to tire of teaching, an all too common phenomenon, and for years he repeated his famous lectures with apparent enjoyment. This course was almost entirely built around his own researches, but so wide had been the scope of his investigations that the field of inorganic chemistry was thoroughly covered. Not a word betrayed to his audience that he was largely responsible for the results being discussed but he smilingly acknowledged the applause at the close of each lecture. As he grew older he neglected the prosecution of new lines of research, but always took pleasure in laboratory teaching. He never found time to do his own work while the students were around, and only occasionally did he incorporate the work of trusted pupils in his papers. Sundays and vacations were devoted to his personal investigations and he frequently began work at dawn.

R. W. BUNSEN

Bunsen had a genius for devising apparatus to suit a particular need and the result of his cogitations was usually surprisingly simple in contrast to the apparent complexity of the problem. He fully appreciated the financial value of applied science, but the idea of patenting such devices as his burner, battery, or filter pump never occurred to him as he could not understand scientific men who attempted to derive monetary gain from their discoveries. He received a call to succeed Mitscherlich at Berlin but refused it, laying down as conditions for remaining at Heidelberg, not an increase in his own salary, but a professorship for his friend, Hermann Kopp, the chemical historian, and an addition to the funds available for his laboratory. He was among the first to make technical practice scientific and to make pure science practical.

Bunsen's thumb was exceptionally broad and with its aid he could

confine a long column of mercury in an open eudiometer tube and immerse it in a mercury trough without admitting a bubble of air, and he simulated great displeasure at the inability of students to accomplish such an apparently simple task. His large, powerful hands were covered with thick tough skin, seemingly insensitive to heat and, when lecturing on his well-known burner, he often amazed his audience by holding his finger in the non-luminous flame until the smell of burning flesh was distinctly perceptible. He seldom needed tongs to remove the lid from a hot crucible. Although proud of his hands in the laboratory, he was very con-

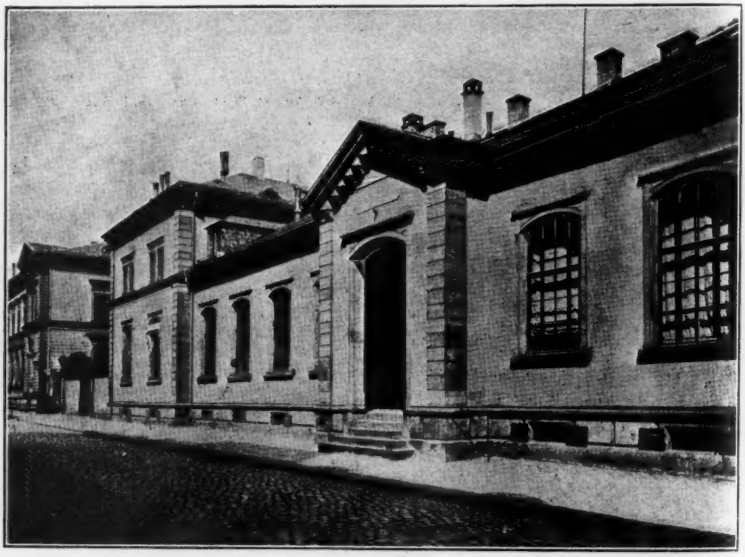


BUNSEN'S HOUSE

scious of their size and appearance when at table with ladies and constantly drew attention to them by his efforts to keep them concealed.

He claimed to be hard of hearing and this infirmity, the real extent of which no one ever knew, was especially in evidence when he found himself in the company of a bore. It is said that he could turn his ears forward and tuck in the fold and shut out distracting noises. When a young man, he had lost the sight of one eye through an explosion in the laboratory, but he never hesitated to undertake a dangerous experiment because of possible injury to the other eye. He literally lived with and for his work, and anything which threatened to interfere with it was viewed with great intolerance. His pleasures were very simple and he thoroughly enjoyed

strolling through the streets or environs of the town, or sitting over a glass with his few chosen intimates. Formal social affairs were avoided when possible, and public display of his honors and orders was for him a painful ordeal. When forced to formally appear with his decorations, he impatiently donned the frock coat on which he kept them pinned or sewed, and then, even in summer, buttoned an overcoat to his chin and sneaked his way through unfrequented streets to the place of meeting. He said, "The only value such things had for me was that they pleased my mother and she is now dead." When addressed as "*Excellenz*," he often replied, "*Lass solche Dummheiten.*"

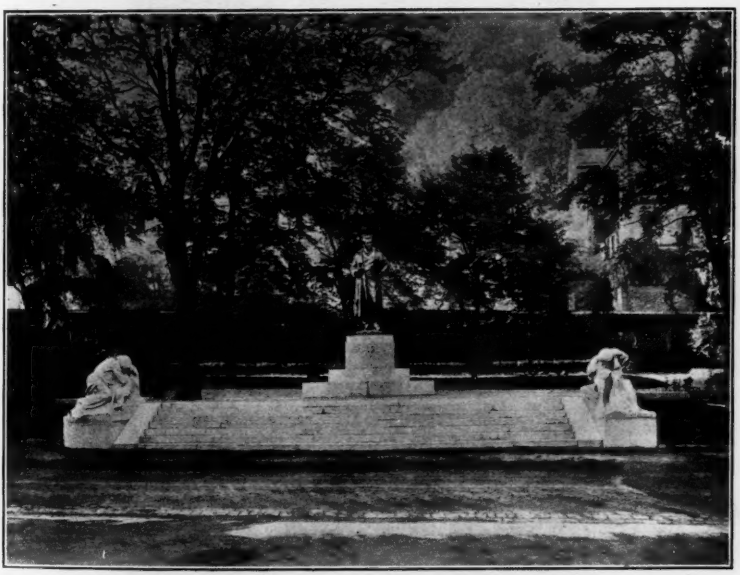


BUNSEN'S LABORATORY, ERECTED IN 1854

Bunsen was by no means a misogynist, but women played no part in his life. He was content with such feminine society as he encountered on his visits to the houses of his friends. Although he claimed that he had never had time to marry, an unauthenticated story has come down that, while still a young man at Marburg, he had proposed marriage and had been accepted. He was in the midst of his research on cacodyl derivatives and became so immersed in this problem that he not only neglected to visit the young lady for several weeks, but became uncertain as to whether he had actually proposed. On his next visit he offered no apologies for his absence, again proposed, and was promptly shown

the door. Frau Kirchoff once asked him why he did not marry. "Heaven forbid," he replied, "When I should return home at night, I should find an unwashed child on each step." (The white marble staircase leading to the living rooms of the "*Wohnung*" consists of twenty-five steps.)

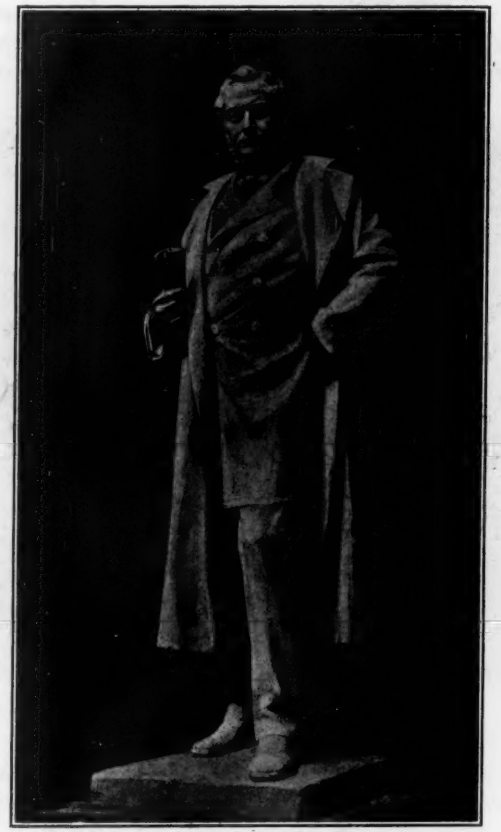
The bachelor quarters were the despair of the good housewives of the faculty. One room was devoted to his worn-out boots ranged neatly against the walls. When the mail was brought into his study, it was often unceremoniously thrown through an open door into a vacant room, and at intervals of weeks or months he would have someone open the



THE BUNSEN MONUMENT AT HEIDELBERG

accumulation and bring the necessary matters to his attention. He never bothered about paying social obligations and the women often took such matters into their own hands. One evening, on his return from the hotel where he took his meals, he found the house a blaze of light. Fearing that fire had broken out, he rushed in to find his gentlemen friends, in evening dress, assembled in his study. They chided him with having forgotten a pretended invitation to them and their families, and opening a door disclosed the next room filled with ladies. Bunsen made the best of the situation and cried out, "Don't open the other door, for all the children are sure to be in there."

He was very fond of travelling, enjoying not only the beauty of nature but using the opportunity to study natural phenomena, especially those of geochemical nature. In his later years, he showed little desire for the exertions entailed by mountain climbing, alleging that he had but one effective lung, which, however, sufficed to carry him into his 89th year.

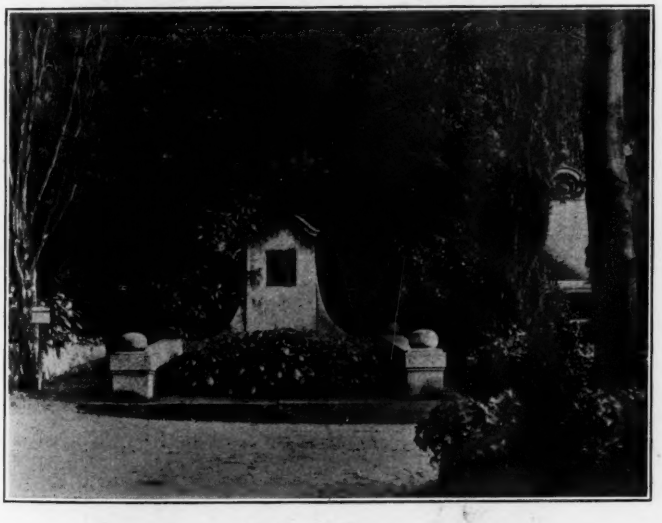


A NEARER VIEW OF BUNSEN'S STATUE

He liked to lie down at the foot of a peak and have his friends cover him with evergreen boughs and wait while they made the ascent. As a protection against the insects, he would cover his face with a large red handkerchief, through which he had burned a mouth-hole with his cigar, and he would pass the time smoking, thinking, occasionally dozing, at

peace with his surroundings, for he had no wife at home to scold about the ruined handkerchiefs.

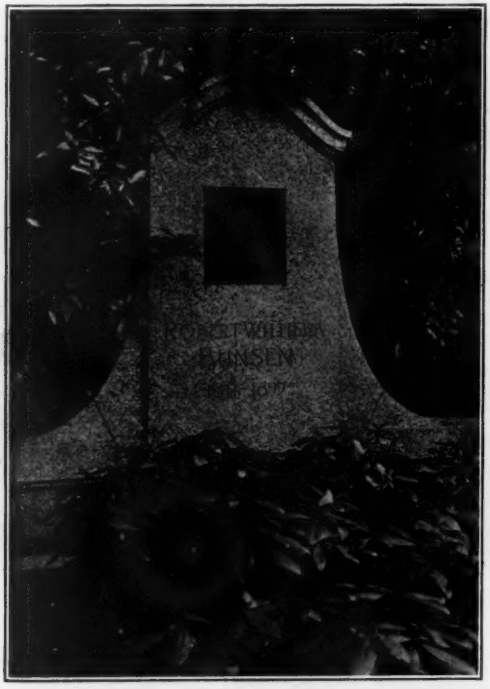
Having received a very thorough training in the classics, he enjoyed, even in his old age, reading Cicero's Letters and Suetonius in the original. He had no appreciation of music and he astounded his music-loving friends by proposing, in the interest of economy, that a very large violin could be substituted for the single instruments of the orchestra. He maintained that the conductor was discourteous when he stood so long with his back to the audience, and he laughingly suggested that the leader be provided with a flexible tail with which to beat time.



BUNSEN'S GRAVE

For over fifty years this lovable genius produced researches of the highest order and assisted in the education of numerous chemical leaders. Many of his discoveries would be front-page news even today. His interests lay entirely in the fields of inorganic, analytical, and what is now known as physical chemistry. He was active during the period of the development and phenomenal growth of organic chemistry, and yet he paid no attention to this movement which threatened to overshadow all the other branches of the science. His study of the cacodyl derivatives, which even the supercritical Berzelius appraised as a masterpiece of chemical investigation, was his only contribution. It extended over six years, involved a risk of his life, and cost the sight of one eye. Having won his spurs, he left the field and never again enlisted in the army of

those carrying on bitter conflicts in this warfare of debated questions. The reasons for this change of his interests are quite evident. Bunsen saw little profit in theoretical discussions, and hypotheses were for him too uncertain a foundation on which to build durable structures. He said, "An hypothesis which permits the coexistence of another, equally as good, is worthless." The endless polemics over questions of chemical doctrine which seemed so integral a part of organic chemistry made no



"THE PLAIN STONE WHICH MARKS HIS GRAVE BEARS NOTHING BUT HIS NAME...."

appeal to him. Furthermore, he had so pronounced a predilection for quantitative work that organic researches did not offer sufficient scope for this passion for exact measurement. The same reasoning probably explains his single contribution to medico-chemistry, namely, the antidotal action of hydrous ferric oxide in cases of arsenic poisoning.

Bunsen's field was distinctly inanimate science, particularly such phases as involved the relation of chemistry to physics and geology. His dictum, "A chemist who is not a physicist, is nothing" gives the setting for a

large part of his work. He was not a mathematician, but he thoroughly appreciated and employed mathematical methods, and neglect of such considerations constituted one of his complaints against organic chemistry, for he implicitly believed that only through mathematical analysis could one arrive at clearly thought-out procedures and exact formulations.

Ostwald wrote that after the death of Berzelius, Bunsen was without equal in the inorganic field. "None other in his time, except Wöhler and Berzelius, had the intimate knowledge of countless materials as did Bunsen." Tyndall said: "The most striking phenomenon at the University was Bunsen. I look back on him as the man who came nearest my ideal of a university teacher. He was every inch a gentleman, and without a trace of affectation or pedantry."

In 1888, at the age of seventy-seven, he decided to entrust his laboratory to younger hands. Emil Fischer was offered the position and he and his wife came to Heidelberg to spy out the land. They found the old master of far more interest than the *Institut* and *Wohnung*. When asked for her impression of Bunsen, Frau Fischer replied, "I wished first to wash him and then to kiss him." Bunsen's successor was his brilliant pupil, Victor Meyer, and after the latter's tragic death, the old man had the pleasure of seeing another of his students, Theodor Curtius, take his place. After living happily and simply for ten years after his retirement, Bunsen quietly died on August 16, 1899. "His soul goes marching on."

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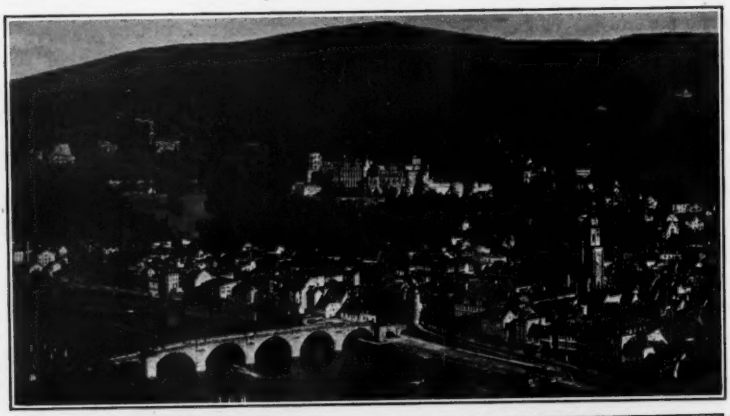
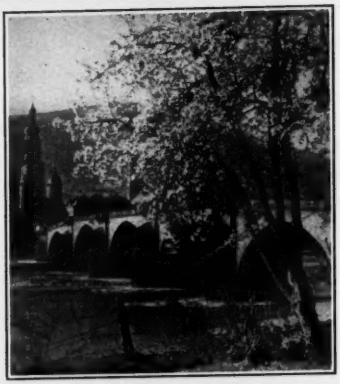
Chemical Research Needed for New Drug Standard. A call has been issued to American chemists to turn their attention to the research problems that must be solved before the eleventh revision of the U. S. Pharmacopoeia can make its appearance in 1930.

Every ten years this authoritative treatise on drugs and their preparation is revised and brought up to date and issued under the supervision of a national committee. A list of the chemical problems involved has been sent out to the chemists of the country in the hope of stimulating research on drugs about which new information is desired. —*Science Service*





VIEWS OF HEIDELBERG

THE STUDY OF CHEMISTRY AT HEIDELBERG: A GLIMPSE OF AN HISTORIC HOME OF RESEARCH

KARL FREUDENBERG, DIRECTOR OF THE CHEMICAL INSTITUTE OF THE UNIVERSITY, HEIDELBERG, GERMANY

"The mass of British tourists who pass through Heidelberg each summer to enjoy the charming scenery of that delightful spot know little and perhaps care less about that which really marks this town as one of the most illustrious and ancient seats of learning in the world. They are satisfied to stroll round the ruins of the Heidelberg Schloss,[1] and to wonder at the Gesprengte Turm[2] outside, and at the Grosse Fass[3] inside the Castle. The very existence of the far-famed Ruperto-Carola[4] is to most of these travelers unknown, and it is only if by chance they meet some corps students in gala costume, or hear of some more than usually serious duel, that it occurs to them that there exists in the town a curious kind of institution called a German university."

With these words the famous English chemist, Sir Henry E. Roscoe, introduces his impressive account of his years as a student at Heidelberg.[5] He worked here as a scholar and friend of Robert W. Bunsen from 1853 onward.

What he wrote twenty years ago still, to some extent, holds good today, though, among educated people, Heidelberg University is known all over the world as an ancient seat of learning. The picturesque town, the world's most magnificent castle ruins, the green woods and mountains, the stately river—all these are so impressive that they very often cause the traveling stranger to overlook the most precious jewel of the old town, the University, founded in 1386. Even if, today, duelling plays no large rôle, and the "curious kind of institution" has become a modern university, the charm of the town and its splendid surroundings, the high scientific reputation and the romantic life of the students still remain. Townsmen, professors, and students heartily welcome foreign students, who have always felt at home within the old walls.

Not a few American chemists received or continued their chemical education at Heidelberg. These friendly relations still exist today, as is proved by the request of the editor of THIS JOURNAL that I should say something about the chemical life of Heidelberg and the training of foreign students.

[1] Castle.

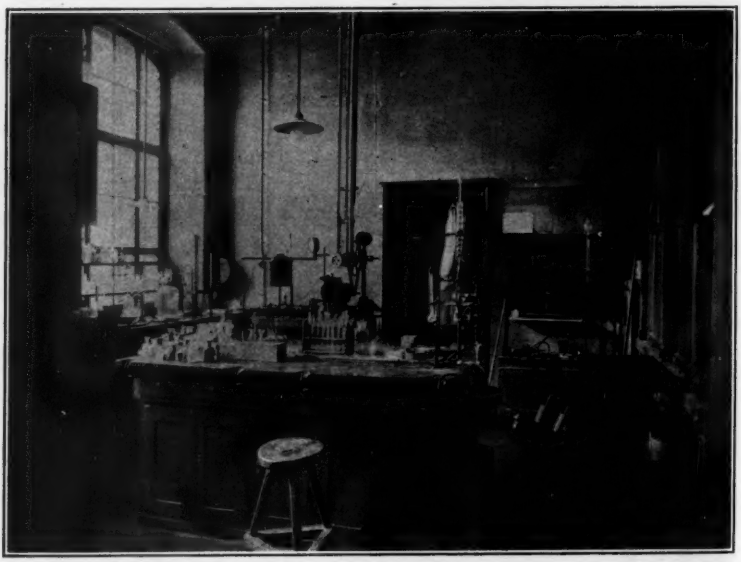
[2] The blown-up Tower.

[3] Great Tun.

[4] Ruperto-Carola University.

[5] "The Life and Experiences of Sir Henry E. Roscoe, D.C.L., LL.D., F.R.S." Written by himself. London: Macmillan and Co., Ltd., New York: The Macmillan Company, 1906.

BUNSEN'S INSTITUTE WHICH NOW SERVES AS A BEGINNER'S LABORATORY



BUNSEN'S PRIVATE LABORATORY

When Robert Bunsen succeeded Leopold Gmelin, the famous author of the inorganic handbook, in 1852, he made Heidelberg one of the centers of the world's chemical research. He built an institute which was a model one for its time, and which now serves as a laboratory for beginners. His private laboratory is still preserved as one of the most venerated of the historic workshops of our science. His house, in whose midst stood his study, in the creeper-clad corner room, serves today as the instruction and research rooms of the physico-chemical department. Here, for 36 years, Bunsen displayed an unexampled activity, and the office which he

BUNSEN'S HOUSE WHICH NOW HOUSES THE PHYSICO-CHEMICAL DEPARTMENT

laid down was taken up by Victor Meyer. This man extended the institute in 1889. Our pictures show the great organic chemistry laboratory, which he built, and one of the lecture rooms. The Institute now had a second flourishing period, this time for organic chemistry. Large parts of the well-known textbook of Victor Meyer and Paul Jacobson had their origin here. When Victor Meyer died in 1897, all too early, Theodor Curtius, the discoverer of hydrazine and azoimide, saw to the continuation of instruction and research. He too extended the Institute by a building which today houses the advanced analysts. When he handed over his office, in 1926, to the writer of these lines, the state took the opportunity of seeing—as well as possible—to the renewal of laboratories and

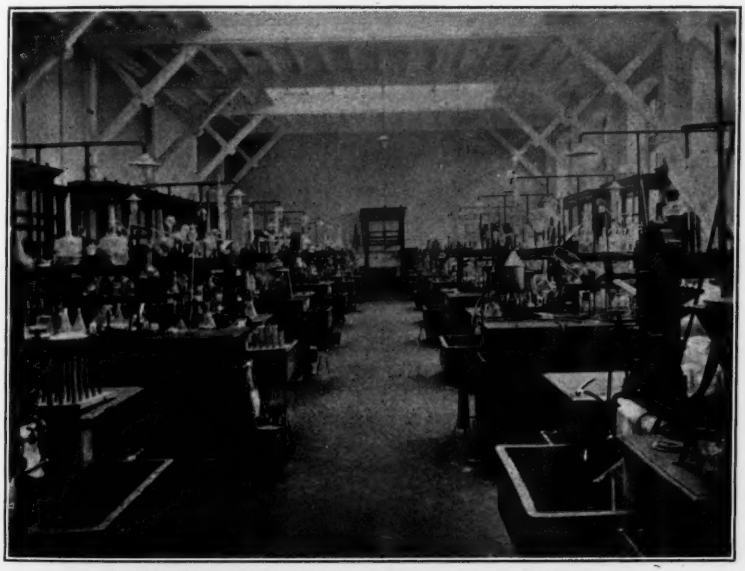
their equipment. In addition to the above-mentioned rooms there are at our disposal special laboratories, optical rooms, workshops, storerooms, and a large library.

Let me name just a few of the numerous teachers of chemistry who worked or taught at Heidelberg during some part of their lives: A. Kekulé, A. Baeyer, H. E. Roscoe, F. Beilstein, H. Landolt, Lothar Meyer, A. Crum Brown, A. Ladenburg, T. L. Thorpe, E. Erlenmeyer, Sr., H. Kopp, A. Horstmann, F. P. Treadwell, L. Gattermann, P. Jacobson, A. Bernthsen, G. Bredig, E. Knoevenagel, M. Bodenstein. The younger generation is endeavoring to carry on the great tradition.

EXTENSION TO THE INSTITUTE, ADDED BY VICTOR MEYER

A staff of professors carries out researches with advanced students on the inorganic side, such as high-pressure reactions, inorganic complexes, problems of affinity; various physico-chemical problems are being worked at. On the organic side researches are being carried on concerning heterocyclic compounds, the valency of the carbon atom, organic radicals, as well as concerning tanning materials, catechins, carbohydrates, lignin, and hormones.

Native and foreign students carry out researches with the instructors. Anyone who comes as Bachelor, with an Honors degree from a recognized university, is usually admitted at once, or after a few months which are



THE ORGANIC LABORATORY BUILT BY VICTOR MEYER

THE LECTURE ROOM BUILT BY VICTOR MEYER

occupied with practical work and end with an informal oral examination, to the "Doktorarbeit." The Doctor's degree (*Doktor der Naturwissenschaften, Doctor philosophiae naturalis*) is acquired by an examination after about two years' research work. In the examination, inorganic, general, physical, and organic chemistry are tested; to these are to be added examinations in physics and a third subject, *e. g.*, mathematics, geology, botany, mineralogy, etc. The necessary lectures and practical tests in the chosen subjects must be attended. This can be done at Heidelberg itself, before beginning the research work or, when no other arrangement is possible, during the research work. It is better when some knowledge of these subjects is brought from home.

Anyone who, after the completion of his chemical training at a university in his home country, comes to Heidelberg for further instruction and merely intends to carry out research work without reading for an examination has far fewer formalities to perform. Living expenses come to about \$500–\$700 per annum, and about \$250–\$300 per annum must be added to this for research work.

It is self-evident that a University with Heidelberg's historical background and old reputation gives opportunity for all kinds of education—on the side of philosophy, history, philology, art, economics, and medicine. Opportunities are provided for sport, particularly for rowing, athletics, and gymnastics. Excursions in the neighborhood are valuable for the natural beauty and the historic associations of the country; longer journeys are made easy by Heidelberg's favorable situation in Central Europe.

Tung Oil Industry Is Developed in Florida. That American tung oil, an urgent need of the national paint and varnish industry, will begin coming into the market before 1928 is the belief expressed by Henry A. Gardner of the Institute of Paint and Varnish Research in a report to the American Chemical Society.

The project of developing an American tung oil industry was undertaken by the American paint and varnish industry some three years ago. Three hundred acres of land in the vicinity of Gainesville, Florida, were planted with tung trees to demonstrate to Florida farmers the possibilities of such a crop. Nurseries were established for distribution to other planters, and it was not long before one organization acquired a large amount of land near Gainesville and planted 1200 acres of it in tung trees with seedlings from the nurseries. In this vicinity there are now about 300,000 tung trees, from one to two years old, some of which are bearing a substantial crop of seeds. The oil yield may range from 400 to 1800 pounds per acre, Mr. Gardner says, beginning from the third to the ninth year. The average producing age of the trees has been estimated at from 25 to 30 years.

From these nurseries and from others established by the Florida Experiment Station, seedlings have been supplied to individuals in Alabama, Cuba, Florida, Georgia, Louisiana, Mississippi, South Carolina, Texas, the Philippine Islands, and Hawaii.—*Science Service*

A SECOND-YEAR CHEMISTRY COURSE FOR COLLEGES

J. E. TAYLOR, WITTENBERG COLLEGE, SPRINGFIELD, OHIO

In too many laboratories conducted for teaching chemistry the procedure has degenerated into teaching students to follow recipes. Very little thought is required of the student and certainly little inspiration to follow scientific study is given.

In an attempt to enliven college chemistry and to avoid thoughtless following of printed directions we have formulated a course for second-year chemistry students in college. This course is being used for the fourth year with sufficient success to justify its publication. The course uses no textbook for a semester and is carried on with very few directions from the instructor. Still, at the end of the semester, the students show a rather surprising proficiency in chemical analysis. During the next semester they are able to follow a standard scheme of analysis from a textbook with such a grasp of the principles that they complete almost as many analyses in this one semester as classes formerly completed during the year. In addition the students have a far more general knowledge of inorganic chemicals and inorganic reactions and a better acquaintance with the methods of scientific work at the end of the course than students used to have after a year's work in qualitative analysis.

A description of the course and its purposes follows. The ideas that governed the formulation of the course are given under the section, "Educational Purposes." Under the heading "Method of the Course" the plan of the course is described and under "Technic of the Course" the application of the method is described.

Educational Purposes

In outlining a new course it is necessary to consider a number of important questions other than the immediate one of the desired changes within the course. The course must be fitted to the general educational aims of the college so that it may be a part of the whole educational scheme, strengthening the students' work in, and receiving support from, the other courses. It is necessary, therefore, to define some of the purposes of the arts college so that a new course may be correctly fitted into the college curriculum. The general aims of the college that were considered in the construction of this course were:

1. To teach community responsibility, that the student might live more efficiently and satisfactorily as a result of his education.
2. To so acquaint the student with different fields of work that he might choose an occupation intelligently, having some knowledge of all the main fields of human endeavor.
3. To give sufficiently thorough, preliminary courses in various fields

that the student can go ahead in any field he may choose without repeating his preliminary training.

4. To so reveal the various fields of work and knowledge that the appreciation of the various arts and sciences may be a source of satisfaction to the student.
5. To encourage the student to educate himself rather than allowing him to take his education passively. To this end he must be encouraged in the view that the laboratory, the library, and the instructor are simply tools for him to use for his education.

It is feared that many courses in our colleges have lost sight of most of these aims except that of feeding information to classes who take the information with only mild interest if not with actual antagonism. The appreciative side of the sciences is too often neglected. The social education that should be one of the greatest gifts of college life is either left to extra-curricular activities or to a few hours of unheeded lectures. Neither of these, the extra-curricular activities nor lectures, are very beneficial. The extra-curricular activities have the virtue of being practised but they are either undirected or directed by groups of alumni whose influence, to say the least, is not always the best that might be desired. The lectures, like most lectures, are seldom thought of in terms of practice and while they may be excellent in content they are practically useless because of lack of practice.

Method of the Course

The attempt to accomplish the aims set out above and the effort to correct to some degree the objections given were made as follows:

1. Community responsibility.

Throughout the year it is impressed on the class that they constitute a small community. Each student is made dependent on the work of the other members of the class and the success of the individual is shown to be dependent on community effort. The methods used here are copied to the best of our ability from Sanderson's work as it is described in Wells' "The Story of a Great Schoolmaster."

2. Acquaintance with chemical work.

The student is given a year's experience in attacking original problems in chemistry. The problems chosen are simple enough to permit solution and still they are of such a nature that original work is required. The solution of these problems is so conducted that the processes of scientific research are duplicated. The class collects data as a community. Each member relies on this community data for the solution of his individual problems. After solution the results are published in the class and are

then carefully tested and criticized by members of the class. This procedure gives a good sample of research work in its various phases and encourages those who have a liking for research to continue in their preparation for more difficult work.

3. Thorough training in the subject.

A large amount of chemical information is given the student by actual laboratory acquaintance with many chemicals and many reactions. The class is taught, through actual application, the fundamentals of chemical analysis. They are also given a working knowledge of the best schemes of qualitative analysis.

4. Appreciation.

In the lecture and quiz work accompanying the course an attempt is made to emphasize the nicety of logic behind the developments touched upon and the methods of generalization used in the treatment of natural phenomena. The course is so flexible that the nature of the work can be fitted to many interests and in this way a wide field of application is open to the class.

5. Encouragement of self-education.

Direct guidance is carefully avoided wherever possible. The student is encouraged to design his own work and to carry it through according to his own plans, not according to an outline from the instructor. The importance of grades is minimized and the importance of accomplishment emphasized. Each student is given work according to his capacity. He is allowed to stretch his mental legs as far as his ability and energy will take him while the sense of competition is controlled so that the slower student is not discouraged. The flexibility of the course thus gives the benefits of sectioning without the necessity for splitting the class.

Technic of the Course

In the school where this plan is being tried the academic year is divided into two semesters and each semester into three six-week periods. This division of time proved very convenient in arranging this course. The discussion below is divided into sections describing the work of each six-week period. The class meets for six hours of laboratory and one hour of quiz each week.

FIRST PERIOD

This is the introductory period. During this period the student is informed of the plan and purposes of the course. An attempt is made to develop in each student the feeling that he is working in the laboratory to increase his knowledge of chemistry and at the same time he is set

to work at gathering information that he realizes the class is going to depend on later for the success or failure of their own work. Each student is assigned one or two metals and instructed to learn all he can about these metals. He understands that the information he gets is to be used later by the class in formulating schemes of analysis. Library work is discouraged at first and the student is told that if he is a good observer the reagent shelves contain all the references he needs. He is given to understand that his work is to become an authority for the class on two metals so that later in the semester he can be relied on for information that will help other members of the class to solve their problems. The student is provided with various compounds of the metals and is led with as little help as possible to try the effects of various other reagents on these compounds.

Through the lecture room the students are led to see that effects that promise the most are the effects of the various negative ions. Since the data are to be used later for formulating schemes of analysis they are led to observe particularly the solubilities and peculiarities of color of the compounds. The effects of excess reagent, temperature, and acidity of solution soon come to their attention and in a few weeks they are systematically testing solutions containing their metals in known concentration with various negative ions under various conditions of temperature, concentration, and acidity.

The results of these tests are recorded on index file cards and at the end of the period are submitted to the instructor as a report on their work for the period.

The following report on the effect of sodium hydroxide on aluminum sulfate is typical.

$+$ ion $= Al^{+++}$ $-$ ion $= OH^-$

$$Al^{+++} + 3OH^- = Al(OH)_3$$

$$Al(OH)_3 + NaOH = NaAlO_2 + 2H_2O$$

100, 10, and 1 mg. of Al gives a ppt. with NaOH. Ppt. is white and flocculent, soluble in acids and strong bases (excess reagent). Not affected by boiling.

Signed.....

These cards are filed uncorrected for the work of the following period.

After collecting all the laboratory data the students go to reference books to find any equations that they are unable to write from their general knowledge and also to find any peculiar reactions that they did not think to try in the laboratory. These unusual tests, like the cobalt nitrate test on aluminum hydroxide, for instance, are then tried out in the laboratory and the results filed with the other cards.

This work makes the student a quite good authority on the common

reactions of a few metals. In addition he comes to realize better the significance of references. He finds the book statements often inadequate for his purposes and he begins to depend more and more on his own observations.

For instance, a reference will tell him that mercuric thiocyanate is insoluble in water. If he depends on this statement to accomplish the separation of mercury from some other metal he is very apt to find himself in difficulties, due to the solubility of this compound in the excess of reagents that are apt to be present. If he tests the formation of this insoluble compound in the laboratory he realizes clearly that it is not suitable for a separation and he is shown here that his own observations are more trustworthy, in some cases, for his purposes than the printed book.

SECOND PERIOD

This is the period of problem solution. Each student is assigned three metals and told to make a scheme of analysis for these metals. He prepares his scheme from the data on the cards that were filed by the class during the first period. He tests his scheme by making unknowns for himself and seeing whether or not his scheme identifies the constituents. When he is satisfied that his scheme is practical he receives an unknown from the instructor and analyzes it. If his analysis is correct he files the scheme with the instructor and proceeds with the formation of a scheme of analysis for four metals different from his first three. This scheme is tested as was the first one. The average student is able to prepare original schemes for the analysis of groups of three, four, six, and eight metals in the course of six weeks. This brings him into contact with nearly all the common metals and by making it necessary to study carefully their properties it gives him a wide acquaintance with metals and their compounds. Attempts to work out schemes of analysis from published schemes are readily detected and are not accepted if any other solution of the problem is possible.

If, through errors in the file cards, the schemes fail to work the student is referred to the observer who signed the card. If the observation is found to be incorrect the second observer notes his correction on the card and signs it, receiving credit for his work. This makes each student an authority on a few metals for the rest of the class and the attitude of a student who has lost several days' work due to another student's faulty observation is far more valuable for discipline than the cut in credit that accompanies such a faulty observation. Community responsibility is clearly demonstrated throughout this work.

THIRD PERIOD

This is the period of publication and criticism. Unsigned copies of the schemes submitted during the second period are distributed among the

students, preferably to members of another section. The students then test the submitted schemes in all ways they can think of and submit a written criticism. The criticisms received are surprisingly keen and well done. Constructive criticism is encouraged and where faults are found suggestions for their correction must be submitted in the report. The sensitivity of the schemes is tested as well as their usefulness on moderate quantities of metals.

This period offers an excellent opportunity for judging the progress of the students.

The final schemes resulting from this course are not fit for publication, of course, but they are the work of the students themselves and the methods work under the limitations of the laboratory.

SECOND SEMESTER

This semester follows rather closely the ordinary trend of a course in qualitative analysis. The students use a good standard text and become thoroughly familiar with the best methods of analysis. The first semester gives the students such a good idea of the methods of analysis and so improves their ability to read and follow printed directions that they accomplish almost as much work during the second semester as former classes used to do in a year's work.

The work is divided as follows:

The first period is devoted to gaining a working knowledge of the best schemes for separating and identifying the metallic ions.

The second period is devoted to becoming familiar with the negative ions and the methods for detecting them.

The third period is devoted to problems of putting materials into solution for analysis and to the analysis of materials of various kinds.

During this last period any students with special interests or special problems are allowed to pursue their problems. For instance, a number of students were interested in the analysis of medicines. They were given pills for unknowns and devoted their time to the detection of any inorganic constituents that were present. One student was interested in paint pigments and worked out schemes for the solution and identification of pigments. Another student noticed that paraffin dissolved in arsenic chloride and that something crystallized from the solution on standing. He spent his whole six weeks in studying this compound and is still working with it.

Many of these individual problems attacked at the end of the course cannot be solved in six weeks. Still others will probably be dropped by students starting them but the important thing is that the student has been given an opportunity to form and try out chemical ideas early in his training. In some cases an interest is aroused and an enthusiasm

stirred up that would never appear under ordinary cramming of facts or would be diverted into other fields.

The killing of enthusiasm in sophomore students through the prospect of four or five long years of preparation for scientific work is one of the most regrettable things in our present system of college education. An attempt to free the student and to let him think and work on his own seems to promise results that will more than pay for the time taken from the cramming of facts.

We have found the course outlined above satisfactory for the teaching of chemistry to second-year students of the subject and we feel that in addition to the chemistry learned the students have been benefited by introduction to a number of things that were not formerly incorporated in second-year college chemistry.

Copper Makes Muck Land Bear Big Lettuce Crops. What is one plant's poison is another plant's medicine. Copper, long regarded as an element not friendly to plant growth, has been used to increase the productivity of certain muck lands used for vegetable growing in western New York, E. L. Felix of Cornell University told members of the American Phytopathological Society recently.

"The productive and unproductive muck look just alike and no biological, physical or chemical differences have been found between them, except in the response to copper treatment," Mr. Felix said. "With copper, lettuce and onions grow normally; without it they do little or nothing. Growers have applied the term 'rabbit ears' to affected lettuce because of the resemblance of the pale, upright narrow leaves to the ears of a rabbit, and the unproductive muck is known as 'rabbit ear muck.'

"Applications of 100 to 200 pounds of pulverized copper sulfate crystals prevented the occurrence of unproductive muck symptoms. Dusting or spraying affected lettuce with small quantities of copper sulfate caused the plants already affected to become healthy in appearance."—*Science Service*

Atoms Act Like Billiard Balls on Tungsten Pool Tables. When an atom of cesium, a metallic element in the same group as sodium and potassium, hits a surface of hot tungsten, such as the glowing filament of a tungsten electric lamp, it doesn't bounce off at once, but rolls around for a distance equal to a million times its own diameter. This was related at the meeting of the American Physical Society by Dr. Joseph A. Becker, of the Bell Telephone Laboratories. But if a cesium atom hits a surface of cesium instead of tungsten, it is bumped right off again.

Radio vacuum tubes with filaments coated with cesium have been found to have an advantage over uncoated filaments.

Dr. Becker learned these facts in a study of the way in which cesium is "adsorbed" on a tungsten filament. When this process takes place, a layer of cesium atoms is formed on the surface of the tungsten wire. In a second, a layer one atom deep is formed on the wire, and then a point is reached where the cesium atoms evaporate from the wire as fast as atoms are adsorbed. He has found, Dr. Becker said, that the average life of one of these atoms on the surface of the filament varies with temperature. At a temperature of 645 degrees Fahrenheit, the atom sticks for a hundred seconds, while at 730 degrees it sticks for only a second.—*Science Service*

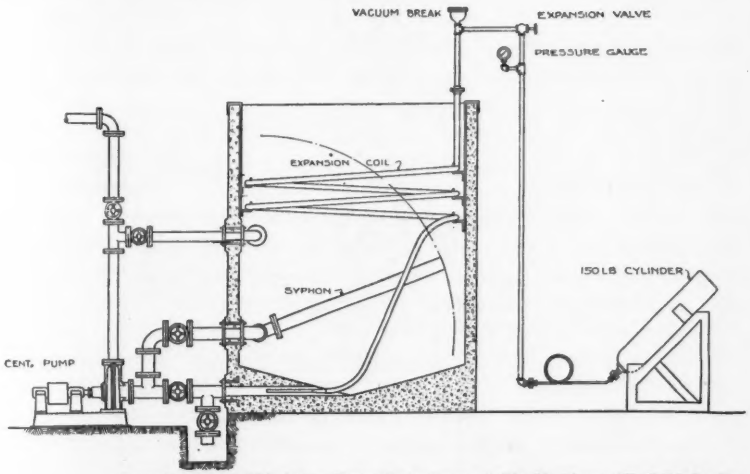
USES OF CHLORINE

ROBERT T. BALDWIN, SECRETARY, THE CHLORINE INSTITUTE, INC., NEW YORK CITY

The earliest known use of chlorine, the bleaching of textiles, was based on the observation of Scheele, in 1774, that chlorine would decolorize vegetable matters. Berthollet, in 1785, appears to have made the first bleaching liquor by dissolving chlorine gas in water. In 1789, Berthollet began the manufacture of *Eau de Javelle* in Paris. This was made by adding chlorine gas to a solution of caustic potash, and was superior to chlorinated water because more stable. Prior to Berthollet's invention the usual European and English process for bleaching linens and cottons was to boil the goods in potash, lime water, or soaps, then steep in buttermilk, and then spread on crofts (small grassy fields) for exposure to light and air. This process required six months' time, and was cut down to three months' time when sulfuric acid replaced buttermilk. There are English records of this sun bleaching as early as 1322, and it was doubtless practiced long before that time, although not originally a native English art and largely imported from abroad. In the late 18th century the English bleachers adopted Watt's steam engine, sulfuric acid, and chlorine bleaching and thus laid the foundations of the present colossal English bleaching trades. Furthermore, the substitution of power spinning and weaving of cottons and linens, in the same century, for the old hand crafts had severely taxed the capacity for sun bleaching, and so these three agencies, Watt's revolutionary invention and the two chemicals, sulfuric acid and chlorine, restored the economic balance. Chlorine made the bleacher, or crofter as he was called, independent of the vagaries of British weather and put the business on a twelve-months-in-the-year basis. Chlorine also did away with the theft of cloth from the crofts. This offence was punishable by ferocious sentences, including the death penalty, as late as 1786.

James Watt introduced Berthollet's *Eau de Javelle* into England, obtaining the process for Charles Tennant. The latter, in 1799, manufactured bleaching powder and from that time onward chlorine in some form has been the bleaching agent most used in the cotton and flax industries and later in the artificial silk industry. Chlorine is not used to any extent in bleaching silks or wools. The exact nature of the chlorine bleaching operation on textiles is still to be absolutely determined and has always been a controversial question. The bleachery processes up to the time of treatment with chlorine in some form are designed to remove as much as possible of all foreign matters and all waxy and fatty matters from the fibers, thus leaving the fibers ready for the final whitening operation with chlorine. It is generally held that chlorine present in bleaching powder, or hypochlorites made either with bleaching powder or liquid chlorine, in aqueous

solutions, brings about the release of nascent oxygen, and that this nascent oxygen in turn oxidizes the coloring matter of the fiber. This theory, however, is open to attack on several grounds. The empirical art is further complicated by the facts that all bleach solutions are more or less unstable; that lime was used in bleaching before chlorine; and that bleaching powder continued the traditional use of lime. The American and German viewpoint in their textile industries is that bleaching powder offers no technical advantages over sodium hypochlorite made with chlorine gas, but the English bleachers still largely use bleaching powder. In American bleaching practice bleaching powder is obsolete for large-scale operations, the lime being considered as having no real function except as a package for the chlorine content.



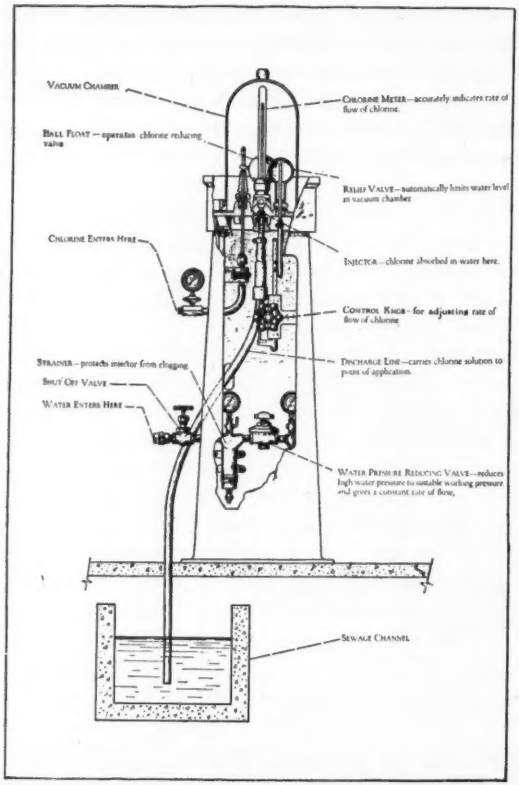
Reproduced from "Mathieson Hypochlorite Process," The Mathieson Alkali Works, Inc.

ONE TYPE OF DIRECT CHLORINATION APPARATUS

The largest single use of chlorine is in the bleaching of paper pulps. This use consumes at least sixty-five per cent of all the chlorine made in the United States of America and Canada. The history of the use is somewhat like that of the bleaching of textiles, as the same considerations apply, that is, the bleaching operation is largely on cellulose in both industries. The paper industry adopted bleaching powder shortly after its appearance. When the chlorine cell became possible after 1890, some very large users of bleaching powder erected cell plants and passed chlorine gas into milk of lime for their own needs.

However, as chlorine derived from the electrolysis of sodium chloride solutions provides chlorine, caustic soda, and hydrogen simultaneously,

or the electrolysis of fused sodium chloride provides chlorine and sodium, and many pulp and paper mills have no use for caustic soda, hydrogen, and sodium, the matter of cell installation in a paper pulp mill is a matter of very complicated economics, and in recent years there have been few cell installations by chlorine consumers. The introduction of the man-


VACUUM CHAMBER
CHLORINE METER—accurately indicates rate of flow of chlorine.
BALL FLOAT—operates chlorine reducing valve
RELIEF VALVE—automatically limits water level in vacuum chamber
CHLORINE ENTERS HERE
INJECTOR—chlorine absorbed in water here.
CONTROL KNOB—for adjusting rate of flow of chlorine
STRAINER—protects injector from clogging
DISCHARGE LINE—carries chlorine solution to point of application.
SHUT OFF VALVE
WATER ENTERS HERE
WATER PRESSURE REDUCING VALVE—reduces high water pressure to suitable working pressure and gives a constant rate of flow.
SEWAGE CHANNEL

Reproduced from "Chlorine in Sewage Purification," Wallace and Tiernan Co., Inc.

ONE TYPE OF SEWAGE CHLORINATOR

ufacture of liquid chlorine in the United States of America has gradually brought about many changes in the application of chlorine to pulp bleaching. Liquid chlorine as such is emptied from the containers into other containers for storage; or is directly applied as a gas through the container valves to milk of lime. Ingenious machinery has been devised to increase greatly the amount of pulp that can be bleached at one time, and it is

good practice to bleach on a huge scale pulps containing as much as fifteen per cent of cellulosic substances.

Chlorine in sanitation has long been known in some form. It appears that de Morveau in France and Cruikshank in England used chlorine gas solutions in sanitation as early as 1800. An English Royal Commission in 1854 ordered chloride of lime used as a deodorant of London sewage. In the eighteen nineties numerous German investigators worked on the chlorination of both sewage and potable water. In 1907 the State Board of Health in Ohio, in coöperation with the Federal Government, carried out chlorine experiments on sewage and Phelps, in the same year, investigated the economic possibilities of the chlorination of sewage. When bleaching powder solutions were first used to sterilize water is unknown, but in 1897 and thereafter it became common practice in America and Europe.

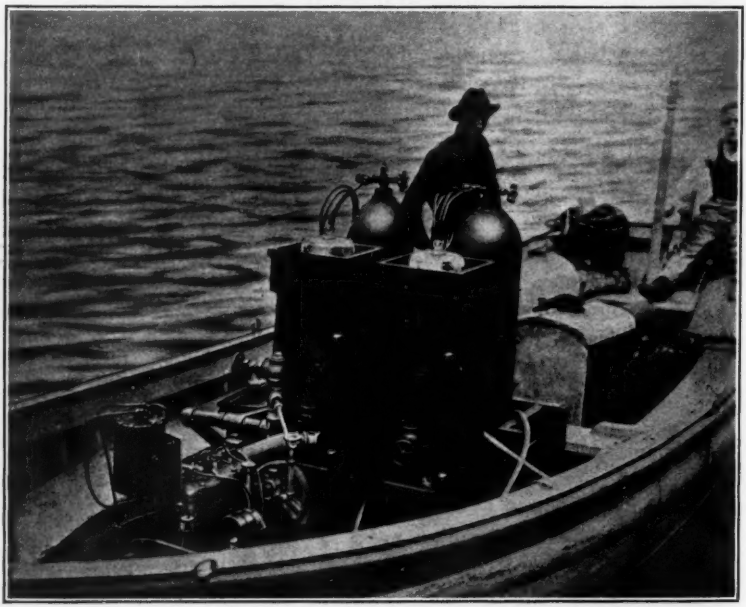
In 1903, Lt. Nesfield of the (British) Indian Medical Service had suggested the treatment of potable water by the use of gaseous chlorine; the chlorine to be obtained by opening a cylinder of liquid chlorine so that the gas could be bubbled in the water to be treated. The first practical demonstration of the possibilities of this idea was made by Major Darnall, Medical Corps, United States Army, in 1910 at Fort Meyer, Virginia. Chlorine gas released from a cylinder of liquid chlorine was uniformly mixed with a constant flow of the water to be treated. In June, 1912, Huy, Kingsley, and Ornstein, using chlorine gas released from a cylinder of liquid chlorine, dissolved the gas in water and then fed the solution to the polluted water supply of Niagara Falls, New York. In November, 1912, Kienle, at Wilmington, Del., made some experiments and secured with valves a constant flow of gas from liquid chlorine cylinders. The gas was absorbed in water, and the resulting solution then fed to the water to be treated, as at Niagara Falls. From these several pioneer efforts there has been built up a water sanitation, with liquid chlorine, in the United States of America and Canada that is a model for the civilized world. Chlorination of potable water supplies is now accepted as essential in the United States of America and Canada where there is any possible chance of pollution. So much so is this the fact that American courts have upheld taxpayers in suits for damages where the plaintiff has been able to show negligence on the part of the water supply authority or purveyor, and very recently courts have held that negligence does not have to be shown.

The chlorination of sewage is the water-supply problem on a larger scale. It is coming increasingly into use, especially in the United States of America, and is the subject of careful research at this time.

The chlorination of indoor and outdoor swimming pool waters is also practised on a very large scale.

Disinfectants and antiseptics ranging from the simple *Eau de Javelle* to such complex substances as the sodium salt of paratoluenesulfochloramide are used in large quantities. The World War gave great impetus to these uses.

The use of chlorine gas in the treatment of some affections of the respiratory tract has been known and practiced at intervals for over one hundred years. Since the World War the Chemical Warfare Service, United States Army, has devoted much research to this matter and there is a



Reproduced from "The Sanitation of Swimming Pools," Wallace and Tiernan Co., Inc.
Chloro-boat Sterilizing the Potomac Park Tidal Basin, Washington, D. C.

renewed interest, and several large clinics for the treatment of colds are in operation in the United States of America.

During the World War great quantities of chlorine were used in the manufacture of chemical warfare gases. As chlorine and its compounds are absolutely essential to the industrial arts, the sciences and the health of a nation, the production of chlorine within economic limits should be encouraged and, moreover, its commercial manufacture is a constant element of military preparedness at no expense to the taxpayer.

Chlorine has numerous uses in the chemical industries, both organic and inorganic. It is probable that the first use for electrolytic chlorine

was in the manufacture of benzaldehyde in the German dye industry.

The uses in inorganic chemical manufactures include the synthesis of hydrochloric acid by either of two methods, the direct union of hydrogen and chlorine or the decomposition of steam in the presence of chlorine; the manufacture of sulfur chloride, anhydrous aluminum chloride, and ferric chloride.

The uses in organic chemical manufactures are much more numerous and include many reactions in the dye industry, the manufacture of carbon tetrachloride and other chlorine solvents; the chlorination of rubber, wax, naphthalene; the cracking of petroleums with anhydrous aluminum chloride; the bleaching of refined petroleums; the chlorination of natural gases for the preparation of amyl alcohol, ethylene chlorhydrin and ethylene glycol; the chlorination of benzene for the production of monochlorbenzene, paradichlorbenzene, and phenol.

The over-large capacity of the chlorine industry, both in United States of America and abroad, is a stimulation to constant effort to find new uses, but the great chemical activity of the element is often a bar to use on a practical scale. It is extremely destructive of nearly all kinds of apparatus. A revolution in its uses can be predicted when some substance entirely suitable for apparatus can be had that will withstand the action of this element and its compound, hydrochloric acid.

In concluding, we see that the element has from the date of its discovery attracted the attention of great scientists; has helped to revolutionize several industries; is an indispensable sanitary agent; can be used to cure or to kill; is a part of our daily lives, and a sentinel of our civilization.

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Morgan Gives Fund for Sleeping Sickness Hospital. A gift of $200,000 presented by J. Pierpont Morgan will enable the Neurological Institute to devote a whole floor of the new hospital they are building to the study and care of cases of encephalitis lethargica, commonly known as sleeping sickness. This will be the first hospital section of the kind to be devoted exclusively to sleeping sickness and places better facilities at the disposal of the medical profession than have hitherto been possible for the study of this much dreaded and little understood disease. The gift is a memorial to Mr. Morgan's wife, the late Jane Grew Morgan.—*Science Service*

GLYPTAL AND MYCALEX—TWO NEW INSULATIONS

GUY BARTLETT, GENERAL ELECTRIC COMPANY, SCHENECTADY, NEW YORK

It is not sufficient that electrical engineers have materials that are good conductors of electricity; it is just as important that they have good insulating materials with which to check electrical conduction. And so different are the operating conditions to which insulations must be subjected that there are hundreds of types of materials used in this work, and every year finds the addition of several more.

Why there are so many insulating compounds is evident from a review of the types of service in which they must be used. In some work it is essential, for instance, that the compound be mechanically rigid and strong; flexibility is a controlling factor in other work. Some applications require heat conduction to carry heat away from winding; others require heat insulation to retain heat in ovens and furnaces. Some devices require insulations that indefinitely resist abrasion; others must have insulating materials that wear down uniformly with the conductors, as in commutators. Some insulations must withstand dampness, moisture, mine waters of acid nature, fumes from chemical plants, or alkalies; others may be completely immersed in mineral oil. These instances of special requirements for insulations are but few of the many conditions to which they are subjected.

Chief among the insulating materials are mica, porcelain, glass, slate, marble, asbestos, varnishes, enamels, paper, cloth, molded compounds, asphaltic and resinous filling or treating compounds, and mineral and vegetable oils. Each of these is, in turn, subdivided into a number of modifications. Insulating varnishes may, for instance, be black or clear, air-drying or baking, flexible or hard.

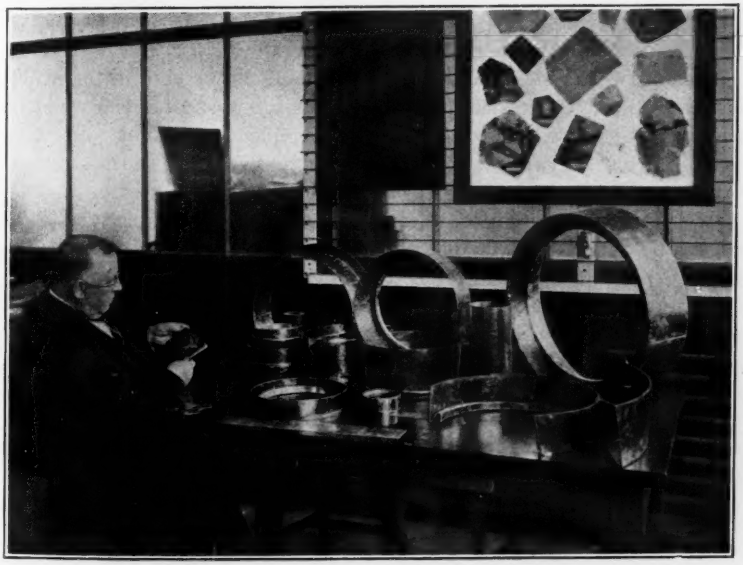
Two of the latest synthetic products to be added to the lists of insulating compounds are Glyptal and Mycalex. The first is one of several synthetic resins developed by the General Electric Company, and is composed of glycerine and phthalic anhydride. It has been developed as a binding material for pasted mica insulation. The other, Mycalex, is made from ground mica and lead borate, and is especially applicable where high frequencies are encountered.

Glyptal—Of Moth Balls and a Soap By-Product

Phthalic anhydride, a few years ago a chemical curiosity produced from naphthaline or moth balls and quoted at $5 a pound and today an important heavy organic chemical used in the manufacture of dyestuffs and selling at 25 cents a pound, has been combined with glycerine, a by-product of the soap industry, to produce a synthetic resin which has succeeded shellac as a binding material in the manufacture of pasted mica

insulation or micanite. The resin, Glyptal, has been standardized for all rigid mica insulation used in the company's apparatus, including segments, cones and backs for commutators, tubes, washers, plates, blocks, molded shapes, etc.

Pasted mica insulation, with shellac as the binding material, was developed more than 30 years ago; and shellac continued as the binder because a more satisfactory material was not found. Experiments with Glyptal as a binder showed that mica plates made with the new resin not only were firmly bonded, but that Glyptal-pasted mica has several other advantages not possessed by the shellac-pasted material.



Representative Glyptal-Pasted Mica Products.

Electrically, it has from 10 to 60 per cent more dielectric strength, depending upon the process of production; twice the resistivity, four times the surface resistivity, and only two-thirds the dielectric loss.

Physically, it is slightly denser, has from one and one-half to twice the transverse strength, is much more translucent, and has about the same compressibility and resistance to abrasion. Mica may slip when shellac is used as the binder, but not when Glyptal is used.

Chemically, neither is affected to an appreciable extent by mineral oils or moisture. Shellac-pasted mica, however, shows a marked effect from heat, has a decided tendency to carbonize, and the products of de-

composition attack copper and are electrically conducting. In contrast, Glyptal-pasted mica shows slight effect from heat, has slight tendency to carbonize, and the products of decomposition do not attack copper and are non-conducting.

All these are important properties in considering insulations, and in practically all of them Glyptal surpasses shellac. Glyptal-pasted mica can be punched, sheared, or otherwise machined as readily as shellac-pasted mica, and there is no more wear upon the tools except slightly more in sawing, due probably to the greater density and solidity of the material. The use of the new mica insulation does not require new or additional equipment to that heretofore used for micanite insulation.

Other Uses for Glyptal

In addition to rigid mica insulation, Glyptal can be used in the manufacture of flexible mica sheets, mica tape, etc. A sheet which could be bent back upon itself was found to have retained its flexibility after five years, whereas linseed oil, spirit, asphaltic, and similar varnishes become brittle and hard in time, due to slow oxidation or distillation.

Glyptal resin, in addition to its uses as a binding material, is also of advantage in the manufacture of ornaments and novelties such as pen holders, pencils, cigar and cigarette holders and other smokers' articles, beads, ornamental boxes, etc. Its advantages in this work are permanence of color and resistance to wear. It can be made in much lighter and clearer colors than other synthetic resins, and its initial colors are permanent—light amber, for instance, does not darken with time. Such colors as snow-white, amethyst, jade, silver, and light amber have been used in making ornamental articles. Luster and smoothness of surface are retained to a high degree, and articles are less liable to breakage than when made from other synthetic resins.

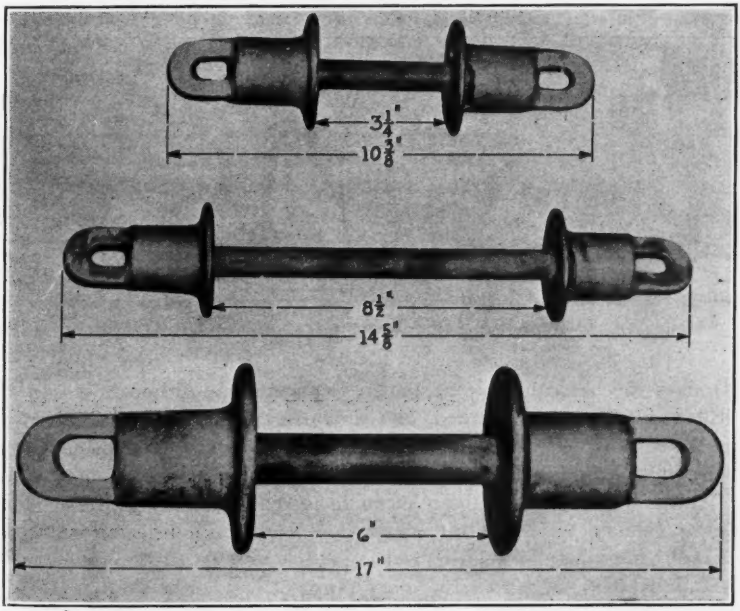
Mycalex—Mica Particles Made Useful

The other new type of insulating material, being used by the General Electric Company for the production of radio high-frequency insulators, not only solves the problem of an improved insulator for such high frequencies as are encountered in radio work but also solves a problem in more efficient utilization of materials. The insulation, Mycalex, is composed of ground mica and lead borate.

Mica presents a difficult problem because of the enormous amount of waste. Obtained in Canada and India in large sheets, there was considerable waste at the mines—it being estimated that only five per cent of the material taken from the mines could be used. In manufacturing, there were further wastes of small pieces of mica, but then it was found that these mica flakes, mixed with a binding material and compressed

under heat, made very good insulation. Such sheets of prepared mica are used by the General Electric Company in many manufacturing processes. And now a product has been developed which utilizes mica particles, so that even more of the mineral is used.

The material has better insulating properties than has porcelain, and several applications for it have been developed by engineers of the General Electric Company. The substance, light gray in color and with a metallic ring, is being used in the manufacture of bases for radio transmitter



Mycalex Antenna Insulators with Aluminum Alloy End Fittings.

tubes, for aerial insulators in high frequency work, and for numerous similar applications.

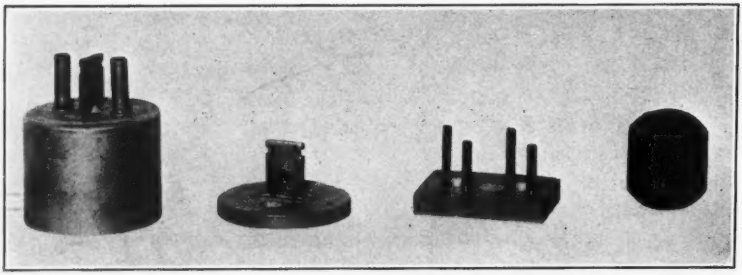
Chief among its characteristics are that metal parts may be inserted or combined with Mycalex during the process of molding; and, although a hard and stone-like product, it can be subjected to ordinary machining methods.

Mycalex is softened or made plastic by heating to a dull red, and the plastic mass is then formed into the desired shape by compression in steel molds. The substance is not as heat-resistant as porcelain or mica, but tests show that it is far superior in this respect to the ordinary molded

insulations made with phenolic resins, shellac, gums, pitches, and similar materials.

The fact that metal parts can be combined with Mycalex during the molding process means a tighter and stronger combination. As a rule, metal inserts cannot be imbedded in ceramic products during the process of manufacture. This is especially true of porcelain because of the considerable shrinkage and the high temperature which causes melting or slagging of metal parts.

Not only has it better electrical properties than porcelain, but it is



Mycalex Parts with Metallic Inserts Molded in Place.

stronger mechanically except under compression. Although it can be drilled, filed, sawed, polished, and similarly treated by usual machining methods, it is necessary in some instances to use special tools since the wear when working with Mycalex is greater than when cutting metals.

The new material has been recommended for use where the requirements demand an insulating material of high mechanical strength, dielectric strength and insulating resistance, low losses with high frequencies, heat resistance beyond the ordinary range of molded or sheet materials, and compact construction with metal inserts securely molded in place.

More Vaccinations Needed in France to Curb Smallpox. General alarm on the part of the health authorities is expressed over the falling off in the number of smallpox vaccinations shown in the annual report for the year 1925 just in from all the departments. The decrease is in part accounted for by the lowered birth rate but much of it is imputed to general carelessness and relaxation in carrying out vaccination regulations.

The Vaccination Commission has called attention to the fact that the present centers of smallpox epidemics at Paris, Douai, Saint Etienne, and Valence originated in cases among Arabs recently disembarked from Algiers. It is strongly recommended that effective revaccination be required in all inhabitants of the French colonies and of the countries under the protectorate of France before they be allowed to enter the mother country.—*Science Service*

THE CHEMISTRY OF PHOTOGRAPHY. II. THE LATENT IMAGE

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A modern photographic or photosensitive material consists essentially of the sensitive emulsion and an inert support. In the previous article, some of the stages of the evolution of this combination have been briefly reviewed. At the present time, the material chiefly used consists of a gelatino-silver halide emulsion on film, glass, or paper support, and only to a small extent of collodion emulsion or wet collodion. As far as photographic chemistry proper is concerned, it is the emulsion that matters. The term itself is somewhat of a misnomer, since it suggests a suspension of liquid droplets in another liquid. Actually what we have is a suspension of solid particles in gelatin.

A very great variety of emulsions are made for different purposes. Although the manufacturing procedures are not disclosed, the elementary chemical principles involved are fairly well known, and an understanding of them should contribute to the benefit both of the user and the manufacturer of photographic materials.

The basic chemical element of modern photography is silver and its relation to the industry was almost prophetically foretold in the following lines from Status' Sylvae.[1]

> "——Argento felix propellitur unda,
> Argentoque cadit."

The silver is originally used in the form of silver nitrate which is prepared from very pure ingot silver. The metal is dissolved in very pure nitric acid and the silver nitrate is recrystallized several times. In making an emulsion, a silver nitrate solution is added to a gelatin solution containing a slight excess over the molecular equivalents of an alkaline bromide, the reaction being

$$AgNO_3 + KBr = AgBr + KNO_3$$

In most negative emulsions a small amount, up to 5 per cent of the silver halide, of soluble iodide is added so that the resultant silver bromide contains a small amount of silver iodide. The emulsions used for photographic papers may consist of nearly pure silver bromide, or of a silver bromide and chloride, or in some cases of pure silver chloride. In the negative emulsions the silver bromide will form about 30 per cent of the total weight of the dry emulsion, but the proportion of silver halide may be consiberably less in emulsions for photographic papers. The precipitation of the silver halide is a very critical and important operation. The particles formed must not flocculate together and separate out but

[1] Quoted in Fabricius, "De Rebus Metallicis," 1565.

FIG 1.
FINE GRAIN
LOW SPEED
EMULSION

FIG 2.
COARSE GRAIN
HIGH SPEED
EMULSION

FIG 3.
SILVER BROMIDE
GRAINS IN ONE
GRAIN LAYER

must remain uniformly dispersed through the gelatin solution. In some processes, an operation called ripening is carried out which consists in digesting the emulsion at a temperature above the melting point of the gelatin jelly. This changes the photographic sensitivity and other photographic properties for two reasons. In the first place the size of the particles is increased; secondly, certain reductions and other chemical processes take place which will be dealt with later. The particles in negative emulsions (Figs. 1 and 2) are definite crystals, although of microscopic and even sub-microscopic size. The larger ones may reach a diameter of 2μ to 3μ (μ equals 1/25,000 of an inch), or in positive emulsions and emulsions for photo-

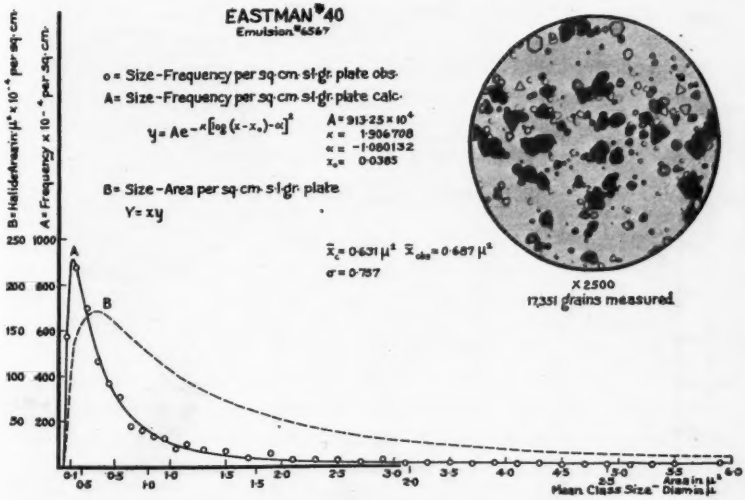

EASTMAN 40
Emulsion 6567
o = Size-Frequency per sq cm sl gr plate obs
A = Size-Frequency per sq cm sl gr plate calc
B = Size-Area per sq cm sl gr plate
Y = xy
A = 913·25 × 10⁴
x = 1·906708
α = −1·080132
x₀ = 0·0385
x̄c = 0·631 μ²
x̄obs = 0·687 μ²
σ = 0·757
X 2500
17,351 grains measured
A
B
Mean Class Size – Diam in μ
Area in μ²

FIG. 4

graphic papers they will not exceed 0.01 to 0.02μ, being indeed mostly below the resolving power of the microscope. None the less, though so minute, they are definitely crystalline as has been shown by X-ray spectroscopy. After the precipitation of the silver halide, usually a second proportion of gelatin is added to bring the concentration of the gelatin up to 7 or 8 per cent and the gelatin solution is set to a firm jelly. This is then shredded and washed in water to remove the excess of soluble salts, then remelted and coated on the support.

It has been stated that the silver halide is finely subdivided and uniformly distributed through the gelatin. In an ordinary negative emulsion on glass or film, there will be several layers of grains, perhaps 15 to 30, and the total number of grains on a unit area is very large. In fact,

"the number may amount to from one-half to five billion per square inch of plate surface, a population of 100 to 1000 times that of greater New York City, on an area not much larger than one's thumb nail."[2] For scientific investigation of these silver halide grains, coatings have been made only one grain thick, and such that the individual grains are clearly separated from each other (Fig. 3). By these means it has been possible to determine the proportions of grains of different size in a given emulsion and to establish the grain size frequency; that is, the relative proportions of grains of different sizes in, say, 1000 grains. These statistical curves (Figs. 4 and 5) have been found to have a distinct relation to the photo-

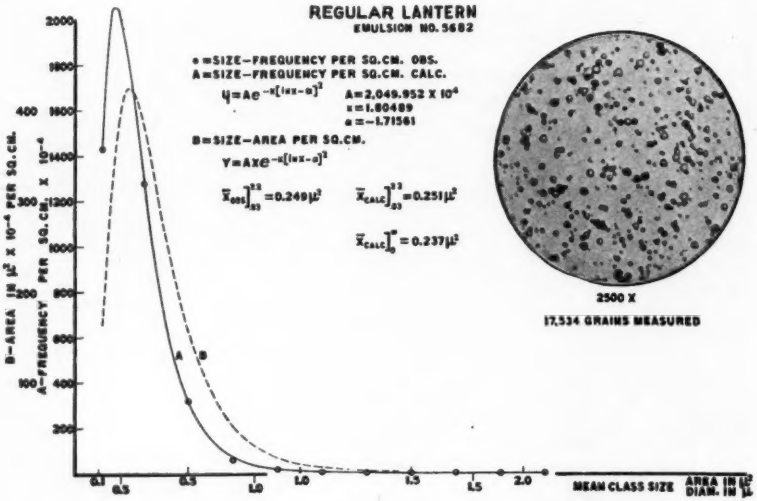


FIG. 5

graphic properties of the emulsion. One may distinguish particularly between a very uniform grain emulsion and a non-uniform grain emulsion, although this presents a very rough division.

We come now to the chemistry of the exposure in a photographic plate or film, and the formation of the so-called latent image. It is desirable to do this now, and to return again to certain aspects of the chemistry of emulsion making which affect sensitivity. To do this, however, some understanding of the formation of the latent image is necessary. It has been known for a long time that on sufficient exposure to light, silver halides lose halogen, although generally in quite minute amounts. In

[2] Calculation by E. P. Wightman, "The Inside of the Photographic Plate," *American Photography*, 1923, p. 329.

recent experiments, working in a high vacuum and using a microbalance, Dr. Hartung has shown that over 90 per cent of the bromine may be removed by light from silver bromide. The nature of the photoproduct, that is, the dark material which is formed on exposing silver halides to light, was long a matter of dispute. Many early investigators considered that a sub-halide, generally attributed the composition Ag_2Hal, was formed, basing their opinion largely on the greater resistance of the photoproduct to oxidizing agents when compared with metallic silver. The American investigator, Carey Lea, showed that in many ways the darkened products, called photohalides, resembled the "lakes" which certain dyes form with inorganic oxides. He showed that products resembling the photohalides in appearance, color, chemical composition, and resistance to oxidizing agents and silver solvents could be prepared synthetically by various processes of partial reduction of silver halides or partial halogenization of silver. In his opinion, the photohalides consisted of "lakes," or as they would now be termed, adsorption compounds, of silver subhalide (Ag_2Hal) with normal halide in varying proportions. Carey Lea also prepared a number of remarkable varieties of colloidal silver. At a later date Lüppo-Cramer, a distinguished German photographic chemist, showed that photohalides having the same properties as Carey Lea's photohalides, could be prepared by mixing a colloidal silver sol with colloidal silver halide sol, precipitating or flocculating the colloids with a strong acid, and then extracting the coagulum with nitric acid. In this way, photohalides of different colorations from deep rose to pale pink could be prepared containing small excesses of silver of the order of one per cent over the equivalent of silver to halogen in the normal halide. From this and other experiments, it has been concluded that the photohalides consist of adsorption compounds of colloidal silver on normal silver halide. A Dutch chemist, Reinders, has found that if silver chloride is crystallized out from ammoniacal solutions containing colloidal silver, colored crystalline photohalides can be produced. There appears then no necessity to assume that a sub-halide is formed.

In the exposures to light used in photography with development, no visible change takes place, and the extent of the change cannot be directly determined by any method of weighing, nor can any visible change be detected microscopically. The change is only made visible by the subsequent application of chemical reducing agents, by which this so-called latent image is developed. For this reason, there have always been two schools of thought with regard to the nature of the latent image, one maintaining that the latent image merely consisted in an extremely minute chemical decomposition of the same character as that definitely discernible at high exposures when photohalides are produced, while the other school maintained that only a physical change had been effected.

The former theory has been much more fruitful in relation to experimental work and there are various observations which speak strongly for it. In the first place, it is possible to destroy largely the latent image by treating exposed plates with certain oxidizing agents which are known to attack silver, for example, chromic acid and potassium permanganate. It is very difficult to see how a particular physical modification of silver halide should be susceptible in exactly this way to oxidizing agents, while the observations are in good agreement with the view that the latent image consists of minute traces of colloidal silver. Indeed, more recent experiments, to which perhaps we shall have occasion to return, have shown that it is possible to distinguish between a superficial latent image on the surface of the silver halide grains, which is rapidly removed by simple treatment with oxidizers, and a buried latent image inside the silver halide

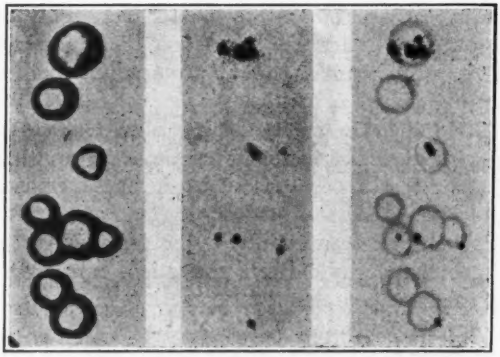


FIG. 6

grains, which is not susceptible to attack by oxidizers, unless the silver halide grain is opened up or dispersed by silver halide solvents, or generally by substances reacting with silver halide itself. There appears every reason, therefore, to regard the latent image as consisting of a reduction product of silver halide, and most probably of colloidal silver. Comparatively recently, and largely through the work of the Swedish colloid chemist, The Svedberg, we have obtained important information concerning the distribution of the latent image among the silver halide grains. It had been shown, previous to Svedberg's work, by M. B. Hodgson and by A. P. H. Trivelli, that if the development of exposed single grains were carried out with a dilute developer and interrupted at an early stage before the grain was completely reduced, that development could be seen to commence at one or more isolated points on the grains (Fig. 6). Svedberg showed that these development centers were statistically dis-

tributed among the grains according to laws of chance. Further, it appeared to be sufficient for a grain to have one such development center to be completely developable, while the chance of a grain having a development center at a given exposure to light increased with the size of the grains in one and the same emulsion.

The controversy which formerly raged concerning the latent image has in recent years been largely transferred to the nature of photographic sensitivity. The point at issue and which is pointed out clearly by these investigations on development centers, is whether the centers arise from pre-existing sensitivity centers, or whether they are purely a phenomenon of development itself. The close connection between the number of centers per grain and the degree of exposure seems to preclude the idea that they are purely a development effect, and to point to the conclusion that they represented the distribution of the active latent image in the surface of the grains. It might still be possible that the discrete character of the latent image, and its chance distribution should result from something confined to the process of exposure itself, and not to conditions preceding exposure to light. In fact, it was suggested by Dr. L. Silberstein that the fact that the larger grains in the same emulsion are apparently more sensitive than the smaller ones, as well as the formation of discrete chance-scattered development centers, were consequences of a corpuscular or quantum character of light energy. Many phenomena, notably the photoelectric effect with metals, have indicated that the energy in radiation is not uniformly and continuously distributed over a wave-front, but localized in a particulate manner, such that it is only emitted, transmitted and absorbed in definite quanta, the quantum of energy being given by the product $h\nu$, where ν is the vibration frequency and h is a universal constant. This is not the place to discuss the pros and cons of the quantum theory of radiation. It must suffice to say that a quantum theory of transmission of light was found insufficient to explain the phenomena of the formation of the latent image. The alternative view supposed that the development centers originated at points in the grain in which a specific sensitivity-giving substance other than silver halide was located, although the nature of the sensitivity-giving substance could not be definitely indicated.

At this point we must return to a consideration of the importance of gelatin in the photographic process. It has been stated that gelatin emulsions enabled a much higher sensitivity to be attained than was ever possible with collodion. While part of this superiority could be attributed to the possibility of producing larger individual crystals of silver bromide in gelatin than could be done in collodion, there still remained an unknown factor. It was well known to emulsion makers that different gelatins could give very different sensitivities when used to make

an emulsion by one and the same procedure. Using the statistical determination of grain sizes previously mentioned, it was shown by Sheppard and his collaborators that gelatins differing in this respect did not bring it about by some colloid chemical factor producing different size distributions of grains. It was further shown by R. F. Punnett, of the Emulsion Department of the Eastman Kodak Company, that extracts could be made from the strongly sensitizing gelatins which conferred increased sensitizing power upon a relatively inert gelatin. A search was made for the sensitizing substance or substances and this was found to consist, at any rate, in a very large measure, of certain organic sulfur-containing bodies, and most notably mustard oil and bodies derived from this. The addition of very small amounts of these bodies to the gelatin used in making an emulsion enables very great increases of speed to be produced, as is illustrated in the following table:

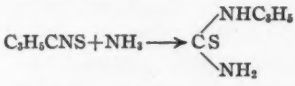
TABLE I

Plate	Concentration of sensitizer*		Log *i*	Speed	Fog
	a	*b*			4′
G	Control		0.50	25.2	0.06
H	1:100,000	0.00110	0.84	120.0	0.06
I	1: 50,000	0.00219	$\bar{1}$.32	368.0	0.08
J	1: 25,000	0.00438	$\bar{2}$.74	1600.0	0.18
K	1: 10,000	0.0110	$\bar{2}$.60	2000.0	0.27

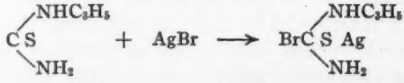
* *a* represents operating concentration on arbitrary scale; *b* represents grams allylthiourea per 100 grams silver halide.

(The definition and measurement of photographic speed will be discussed later.)

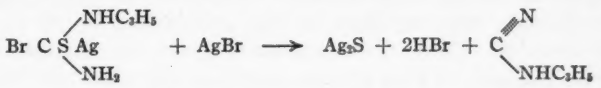
Although the action of these photographic sensitizers has not yet been entirely cleared up, certain aspects appear definitely established. If we take allyl mustard oil as typical, there is no reaction between this and silver bromide. But allyl mustard oil and ammonia react to form allyl thiocarbamide which is quite soluble in water. The thiocarbamides



react at once with silver halides, forming at least two series of double compounds. Where the silver halide is greatly in excess, as in the present instance, only the first series of compounds, in which one molecule of silver bromide unites with one molecule of thiocarbamide, is formed,



These double compounds are not very soluble in water. The order of solubility decreases from the silver chloride compound to the silver iodide compound, the last having hardly any appreciable solubility at ordinary temperatures. It does not appear that these compounds form the actual sensitizing nuclei. When treated with slightly alkaline solutions they decompose, yielding silver sulfide and certain organic reaction products,



Since the sensitization is definitely effected after treatment of the emulsion at such alkalinities as produce silver sulfide it is evident that the silver sulfide is the effective sensitizer. The amount of it on silver halide is extremely small, being of the order of one part in 50,000.

The sensitizing action of the silver sulfide specks which may or may not in certain cases be reinforced by traces of colloidal silver associated with them, is still a matter of considerable uncertainty. It belongs in the great field of heterogeneous catalysis at surfaces and interfaces, and will no doubt require considerable investigation for its full understanding. Before sketching, however lightly, the hypotheses proposed, it will be necessary to consider the chemistry of photographic development.

Paraffin Bathing Suit Saves Wood from Shipworms. Blocks of wood given a special paraffin treatment have stayed under water along the Atlantic coast for almost two years without being attacked by the ferocious shipworms that swarm in these waters, according to findings made by the Chemical Warfare Service.

The paraffin treatment under test was devised and patented several years ago by Dr. Paul Bartsch, noted marine biologist of the U. S. National Museum. After recent examination, the protected blocks were replaced in the water so that the endurance contest between the wood and the worms may continue.

Dr. Bartsch's discovery has attracted considerable attention because of the enormous damage to wooden wharves, ships, and houses caused by shipworms, ants, bacteria, and fungus plants. The process consists in penetrating all the tissue of the wood with melted paraffin and two kinds of paraffin-soluble poisons. Two poisons are used, Dr. Bartsch explains, because suitable chemicals which are deadly to animals fail to destroy plant life, and vice versa.

Whether the paraffin armor protects wood indefinitely against land armies is being tested at the Biological Station in Barro Colorado Island in the Canal Zone. Blocks of wood treated with the paraffin process have been kept buried in a white ant cemetery since February, 1924. When the blocks were last dug up, temporarily for examination, by a biologist at the station, he reported that the wood was still keeping the ants at bay after two and a half years, and no sign of dry rot or decay of the wood had taken place.—*Science Service*

THE VITAMINS. VI

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Summary of Some of the Properties of Vitamins A, B, C, D, and E

On the basis of relative solubilities these five vitamins are divided into two groups: the water-soluble vitamins B and C and the fat-soluble vitamins A, D, and E. It seems fairly certain that neither of the water-soluble vitamins bears any close chemical relationship to any of the fat-soluble vitamins. Thus the separation of these five vitamins into two groups on the basis of their relative solubilities in water and fats, while it is doubtless superficial and may prove chemically meaningless, is not likely to do violence to any chemical relations which may be established later.

Whether the water-soluble vitamins B and C are chemically related to each other we do not know; it seems unlikely. Vitamin B is in all probability a nitrogenous base (perhaps also an organic acid); regarding vitamin C we have no equally strong evidence, but such indications as we now have seem to point rather in other directions—certainly it is a much more easily oxidizable substance than is vitamin B. Also vitamin C does not seem to resemble vitamin B in behavior toward adsorbents. Both vitamins B and C are fairly diffusible through ordinary membranes, and fairly soluble in alcohol or alcohol-water mixtures. There is no evidence that they are in any sense interchangeable, nor in any definite way interrelated in their nutritional functions; but each in addition to its specific effect, as antineuritic and antiscorbutic, respectively, is needed for growth (with the possible exception of C in some species) and has an influence upon the ability of the body to resist invasion by pathogenic bacteria. Of neither vitamin B nor C does the animal body appear to be able to store any large reserve; but whereas all animals which have been studied seem to need vitamin B, some species of animals are able to thrive with little if any vitamin C in their food. Whether this is because they synthesize vitamin C, or do not employ it in appreciable amounts in their nutritional processes (possibly using something else in its place), we do not know with certainty; but the fact that livers of rats and of chickens have been found to contain vitamin C when these animals had been for long periods on diets apparently devoid of it, seems to suggest that, for certain species at least, there may possibly be sources of vitamin C within the animal body—again unlike vitamin B.

Beyond the fact that some vitamin C is formed in the sprouting of seeds, very little is yet known regarding the where, when, or how of the production of vitamins B and C in plants. Vitamin B appears to be much more uniformly distributed in the various tissues and juices of plants and animals than is vitamin C.

VITAMINS IN FOODS

	"A"	"B"	"C"	"D"
Bread (Water)	—	+	—	—
Bread (Milk)	+	+	—	+
Bread, Whole Wheat (Water)	+	++	—	—
Bread, Whole Wheat (Milk)	++	++	?	+
Barley (Whole)	+	++	—	
Corn, Yellow	+	++	—	
Oats	+	++	—	—
Rye, Cracked	+	++	?	
Wheat, Kernel	++	+++	—	+
Wheat, Bran	+	+++	—	
Liver	++	++	?	+
Kidney	++	++	+	+
Brains	+	++	?	+
Heart	+	+	+	+
Fish, Fat	+	+	?	—
Fish, Roe	+	++	?	+
Milk, Fresh (Unpasteurized)	+++	++	++V	++
Milk, Condensed	+++	++	+V	+
Milk, Evaporated	+++	++	?	
Milk, Dried (Whole)	+++	++	+V	
Milk, Skimmed	+	+	+V	
Buttermilk	+	++	+V	
Cream	+++	++	+V	
Butter	+++	—	—	+
Cheese	++	++	—	
Eggs	+++	+	—	+
Almonds	+	++?	*	
Coconut	+	++	—	+
Hickory Nuts	*	++	*	
Peanuts	+	++	*	
Walnuts	*	++	*	
Tomato (Raw or Canned)	++	+++	+++	
Beans, Kidney	+	+++	*	
Beans, Navy	+	+++	*	
Beans, String	++	++	+	
Beets	—	+	+	
Cabbage, Raw	++	+++	+++	
Cabbage, Canned	*	*	++	
Cabbage, Cooked Briefly	++	++	+	

+....Contains the Vitamin.
++....Good source of the Vitamin.
+++....Excellent source of the Vitamin.
—....No appreciable amount of the Vitamin.
?....Doubt as to presence or relative amount.
*....Evidence lacking or insufficient.
V....Variable.

(Bureau of Investigation of the American Medical Association, 1926.)

VITAMINS IN FOODS (*Concluded*)

	"A"	"B"	"C"	"D"
Carrot, Raw	++	+	+	
Carrot, Cooked	++	+	+V	
Cauliflower	+	++	?	
Dandelion Greens	++	++	+	+
Lettuce (Garden)	++	++	+++	+
Onions	?	++	++	
Parsnip	—	++	?	
Peas, Fresh	++	++	+++	+
Potato (Boiled)	+	++	++	
Sweet Potato	++	+	?	
Rutabaga	—	++	+++	
Spinach, Fresh	+++	+++	+++	
Spinach, Canned	+++	+	+++	
Squash	++	?	?	
Turnips	—	++	+++	
Apples	+	++	++	
Bananas	?	+	+	
Grape Juice	?	+	+	—
Grapefruit	?	++	++	—
Lemon Juice	—	++	+++	
Orange Juice	+	++	+++	
Pineapple (Raw or Canned)	++	++	+++	
Raspberries (Raw or Canned)	*	*	+++	
Peaches (Raw or Canned)	++	+	++	

The fat-soluble vitamins A, D, and E all seem to be closely related to the group of substances known as "sterols;" and, therefore, may not improbably be chemically related to each other, though this is by no means certain. The occurrence in connection with fats and the known physical properties of the fat-soluble vitamins plainly entitles them to classification among the lipoids; but it is not customary to call them lipoids because their most characteristic and most significant properties, namely, their vitaminic potencies, set them off so strikingly from all of the lipoids previously known. There is no evidence that any of these fat-soluble vitamins contains any other chemical elements than carbon, hydrogen, and oxygen; and without repeating here the summaries of properties given in connection with each (for each of the papers of this series is itself merely a condensed summary), it may be recalled that vitamin A very closely resembles the typical sterols in its chemical and physical properties so far as these are yet known, and that vitamin D is known to be derivable from one or more of the typical sterols by the action of ultra-violet light. Also vitamins D and E seem to show a close similarity in their known chemical and physical properties. They seem much more resistant to heat and oxidation than does vitamin A, although vitamin A is doubtless more stable than is generally supposed.

All three of the fat-soluble vitamins are formed in plants; vitamins A and D, at least, in the green parts and under the influence of sunlight. This seems probably true of vitamin E also in view of Evans' observation of the greater vitamin E content of the milk of cows when on fresh green pasturage.

As the animal body has the power of storing fat-soluble vitamins to a very important degree and of furnishing them for their offspring through the medium of milk and of eggs, some foods of animal origin are very important sources of these vitamins, even though it seems probable that no vitamin A or E originates in the animal body. One of the important services of farm animals to man is the gathering and concentrating, chiefly in the fat of milk and of eggs, the fat-soluble vitamins of such coarse, leafy foods as are not well suited to direct human consumption.

In the case of vitamin D it would seem that there is also an actual production of this or some nutritionally equivalent substance in the skin of the animal, whence it is conveyed by the blood to other parts of the body.

With these few words by way of summary of the relationships and differences of the water-soluble and the fat-soluble vitamins, respectively, let us now pass to a brief, concluding glance at the vitamins (especially the longer known members, vitamins A, B, and C) as a group, and their significance in the practical problem of the human food supply.

As they are not all related chemically and are in no wise interchangeable in nutrition, it may well be questioned why the vitamins should be grouped together. Doubtless it is largely due to the fact that they all differ from the previously known food constituents in being organic foodstuffs which occur only in very small quantity and yet function in newly discovered and striking ways in nutrition.

One other thing which they seem to have in common—at least the three for which we have methods for quantitative determination of relative amounts, viz., vitamins A, B, and C—is that, like fresh air and unlike most other constituents of foods, they seem to be beneficial in amounts many times greater than the amounts which are actually needed. If we eat several times the amount that we need of fat or carbohydrate, we must soon suffer either from indigestion or obesity; if of protein, we suffer in other ways; but of vitamins A, B, and C there seems no danger of any disadvantage from an intake of almost unlimited liberality. Assuming that we do not experiment with "concentrates" or other drug forms of vitamin but get our vitamins in our daily food, there seems to be no limit to the extent to which the foods now known to be important sources of vitamins A, B, and C—notably milk, vegetables, and fruit—may wisely be made increasingly prominent in the dietary. The more largely we satisfy our appetites and energy requirements with foods of these types,

the better the margin of safety in our intake of vitamins A, B, and C, and the better our chances of resisting infections and enjoying the highest attainable degree of positive health.

As an impersonal summary of the values of numerous staple foods as sources of vitamins A, B, C, and D, we have reproduced, in tabular form, the chart recently published by the American Medical Association.

Red Blood Cells Found in Mummies 1200 Years Old. Finding of red blood cells in two Peruvian mummies 1200 years old has been reported by Dr. Herbert U. Williams, of the University of Buffalo.

Previous efforts to find traces of red blood in Egyptian and other mummies have not been successful, though a great number of mummies have been examined and other remarkable evidences of preservation have been described. Several anatomists have reported, in the past, signs of what might be red blood cells in dinosaurs millions of years old, but such evidence has been considered inconclusive and doubtful.

Dr. Williams states that the discovery of red blood cells in the mummies was unexpected. But microscope studies and chemical tests led him to the conclusion that unusually favorable circumstances must have made it possible for a few of these fragile structures to survive in the tissues even through so many centuries. In one of the mummies he found what he interpreted to be "an old hemorrhage, with survival of a few of the red corpuscles, but with disintegration of the majority."

Dissection of the mummies also revealed arteries, nerves, muscles, and tendons, which could be readily identified.

Dr. Williams' findings, he states, indicate that much could be done by study of such mummies to determine the diseases of early American races, especially diseases of the chest and abdomen.—*Science Service*

Bullets of Atomic Mercury Demolish Molecules. A new method of chemical decomposition by which "excited" mercury atoms collide with the chemical molecules and split them apart into their constituents just as a bullet from a rifle shatters a clay pigeon, was recently described by Prof. Hugh Stott Taylor, chairman of the chemistry department of Princeton University.

This method, which has been developed in the Princeton laboratories by John R. Bates, Charlotte Elizabeth Procter Fellow in Chemistry, shows that the effect of high temperatures on chemical compounds can be imitated at ordinary room temperatures by introducing into the system mercury atoms endowed by light with high energy.

In this way, water molecules are broken into fragments of hydrogen and oxygen, ammonia into nitrogen and hydrogen, reactions which are generally achieved at high temperatures.

The fragments of the decomposing molecule are very reactive and new combinations can, therefore, be secured. Thus, when benzol is shattered in the presence of oxygen, phenol or carbolic acid is obtained.

According to Prof. Taylor, such a reaction would be of great commercial importance if cheaper methods of producing "excited" atoms could be found. Experiments in this direction are in progress at Princeton as well as the investigation of "excited" atoms of zinc and cadmium.—*Science Service*

THE CHEMISTRY PROFESSION: PREPARATION, OPPORTUNITIES*

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Science is defined as the systematic study and classification of facts. We must also consider the hypotheses, theories, and laws which enable us to interpret these facts. Science has many overlapping branches, one of which is chemistry. This has been defined as the branch of science which deals with the composition and properties of matter. As we are living in a material universe, chemistry is all-embracing and may be looked upon as the basic branch of science; indeed, progress and civilization are inseparably linked with chemistry. Developments in this field since the beginning of the twentieth century have been so remarkable that many are inclined to christen the period in which we are living "The Chemical Age."

A description of the occupation of the chemist is difficult because of the vast scope of this branch of science. The chemist might be engaged: (1) in "analysis," determining the composition of material submitted to him, (*a*) for the purpose of ascertaining its nature; (*b*) its safety or purity for specific uses; (*c*) its uniformity or compliance with specifications set in manufacture; (*d*) its utility as a raw material in a manufacturing process; (2) in "synthesis," trying different combinations under a variety of conditions to produce a material for any one of innumerable purposes; here the operation may range from the small-scale laboratory experiment to large-scale production in the manufacturing plant.

Chemistry is broadly classified into the four divisions, inorganic, organic, physical, and analytical. (1) Inorganic chemistry includes a study of the chemical elements and their compounds, excluding, however, over a hundred thousand compounds of carbon with hydrogen, oxygen, and nitrogen, which come under organic chemistry. Originally, the inorganic division included only substances of the mineral kingdom, supposedly not found in living organisms. It is no longer possible to make this fine distinction, because of the overlapping of divisions. (2) Organic chemistry is concerned with the preparation and study of the hundreds of thousands of carbon compounds referred to above. Many of these are found in living organisms, hence the designation "organic." It must not be assumed that all are encountered in living things. (3) Physical chemistry is engaged especially in establishing definite relationships between composition and physical properties of materials, and encroaches on the domain of physics. (4) Analytical chemistry deals principally with composition, including methods for separating and determining ingredients.

* Presented before the Division of Chemical Education at the 73rd Convention of the American Chemical Society, Richmond, Virginia, April 14, 1927.

A review of these brief statements concerning the four general divisions gives evidence of the impossibility of clearly defining each and establishing fixed dividing lines.

The fields in which any or all of the above may be employed are:

(*a*) *Education.* This will be discussed at greater length later.

(*b*) *Agricultural chemistry.* The study of conditions desirable for plant nutrition and protection.

(*c*) *Biological chemistry.* Investigation of effects of chemical substances on living organisms. This may include physiological chemistry, or reactions going on in the human body, with tests to ascertain the condition of the body, or its parts; toxicology, or the detection and study of poisons, with their antidotes and cures.

(*d*) *Pharmaceutical chemistry.* The preparation of drugs and medicinal agents. This may include serology, or the production of serums to combat diseases caused by bacteria and other microörganisms.

(*e*) *Pathology.* The study of diseases, their nature, progress, and symptoms.

(*f*) *Sanitary chemistry.* The treatment and care of air, water, and food supplies, and inspection to guard against the use of harmful preservatives or adulterants; also the disposal of sewage and other waste.

(*g*) *Dietetics.* The apportioning of fats, carbohydrates, proteins, water, mineral salts, vitamins, etc., for normal diet and the preparation of special menus for abnormal cases. This is linked with biochemistry.

(*h*) *Textile chemistry.* The study of natural and artificial fibers and their behavior toward dyes and other chemical and physical agents.

(*i*) *Metallurgy.* The production of metals from ores. This is a vast field, including aluminum, copper, iron, lead, nickel, silver, tin, tungsten, zinc, the rarer metals, and innumerable alloys. Metallography, the study of metals under the microscope, is related to metallurgy.

(*j*) *Fuel chemistry.* The manufacture and evaluation of gaseous, liquid, and solid fuels on the basis of calorific or heating value, safety, utilization of by-products, etc.

(*k*) *Electrochemistry.* The use of electricity for the production of desired materials, either directly or through electrical generation of heat.

(*l*) *Ceramic chemistry.* Production of brick and refractories, china, porcelain, enameled ware, glass, abrasives, etc., to meet general and specific requirements.

(*m*) *Optico chemistry.* Identification and utilization of substances, because of light absorbed or emitted under various conditions. Also a study of the effect of light and its various radiations on photographic materials, dyes, plants, and other substances. Astrochemistry, through use of the spectroscope, has given us the chemical composition of the heavenly bodies. X-ray studies have lead to atomic and molecular constitution.

(*n*) *Cellulose chemistry.* The production of paper, celluloid, gun cotton, artificial silk, leather substitutes, lacquers, etc., from wood and cotton.

(*o*) *Explosives chemistry.* Manufacture of T.N.T., nitrocellulose, nitroglycerine, picric acid, and powders.

(*p*) *Adhesives.* Production of mucilage, paste, glue, varnish gums. The last, with their solvents, drying oils, and pigments, yield varnishes and paints.

(*q*) *Radiochemistry.* Manufacture of radium compounds and other radio-active substances for use in medicine and luminous materials.

(*r*) *Vegetable oils and fats.* Utilization as food products and in the manufacture of soaps, lubricating greases, and glycerin.

(*s*) *Rubber chemistry.* Fitting the crude material for fabricating rubber goods, and devising means for the possible production of artificial rubber.

(*t*) *Dyes.* Their preparation from the coal tar formed in coke manufacture, and from other raw materials.

(*u*) *Acids, alkalies, and salts.* The commoner chemicals used in practically every chemical industry. Many special chemicals must also be prepared for use in industry and laboratories.

(*v*) *Research.* This may include investigation leading to new developments in any of the above fields of applied chemistry, or it may be conducted in "pure chemistry" adding to our store of general knowledge. Pure chemistry may prove of enormous value to applied chemistry from time to time.

(*w*) *Library service.* Training as librarian in the technologic field. The bibliographer is a part of the technical staff of many of our large manufacturing establishments.

(*x*) *Salesmanship.* A knowledge of chemistry is indispensable in the sale of certain technical products, and an advantage in the disposition or purchase of many others.

(*y*) *Literary work.* The writing of reliable technical and popular books is important. In journalism the increasing tendency toward publication of scientific articles opens another field for chemists.

Preparation Desirable

Too much cannot be said of the high-school training preparatory to entering college. No student who does not possess real ability in physics and mathematics should think of chemistry as a profession. He should devote as much time as possible to mathematics in the high school, getting thorough training in arithmetic, algebra, geometry, and trigonometry. He should have at least one good course in physics. One course in high-school chemistry is ample. English should be mastered. Nothing is more important than clear expression and a correct, concise statement of facts. Many a technical man fails through inability to properly impart his

knowledge. As both the written and spoken language function, a course in public speaking or elocution is also of value. Most colleges offer courses in German for chemistry students. A fair knowledge of another language is an asset. Several courses in high-school French seem desirable. Spanish is advocated for those who plan to cast their lot in South American countries, some of which offer excellent opportunity in the technical field. As chemistry curricula in our colleges are of necessity heavily laden with mathematics, physics, and chemistry, little time is available for the so-called cultural subjects. The student is advised to take history, literature, political science, botany, and other "general culture" courses, offered in high schools. It is an advantage, in mingling with non-technical men, to be able to talk about something beside chemistry.

A strong healthy body is desirable in the prospective chemist. He may, at times, be exposed to laboratory or plant fumes, although laboratories and plants are, in most cases, well ventilated. He has to work hard with both body and mind. Chemistry is not a field for the "weakling."

For those who plan to enter the industries or become assistants or instructors in chemistry in colleges or universities, the college courses lead to the B.S. (Bachelor of Science), B.Chem. (Bachelor of Chemistry), or the B.S. in Chemical Engineering degree. In the writer's estimation, the minimal college training should include several courses in German; mathematics through calculus; a course in physics, with special emphasis on applied heat, light, and electricity; a short course in drafting; a course in inorganic chemistry; one in analytical; one in organic; one in physical; a short course in fuel examination and one in optico-chemical methods. These are minima. More training in physics and the fundamental chemistry courses is an advantage. Other courses may be added according to plans for the future, *i. e.*, food and sanitary chemistry, industrial chemistry, electrical and mechanical engineering, biology, bacteriology, mineralogy, geology, labor and costs, factory management, etc. The writer has not included English although this is listed in most of the chemistry curricula. It would seem reasonable to expect an American, who has studied English eleven years in the grade and high schools, to be able to use the language correctly and acquire his technical terms through reading college textbooks.

For those who plan to teach chemistry in high schools, the following minimum is recommended. Two courses in mathematics; two in physics; one each in inorganic, analytical, organic and physical chemistry; one each in elements of teaching and practice teaching. It might also be advisable to study English, a foreign language, and botany or zoölogy. In the larger urban high schools, the teacher is expected to instruct chemistry classes only, but in smaller institutions he might be assigned to a naturally related group of subjects, like chemistry, physics, and mathematics. Botany

and zoölogy are included to help prepare one for general science, if it has to be taught.

For students planning to engage in research, assume supervisory responsibility in laboratories and plants, or teach chemistry in colleges and universities with a professorship as the goal, graduate study toward a Master of Science, Chemical Engineer, or preferably Doctor of Philosophy degree is essential. The M.S. may be obtained in one year, the Chem. Eng. in two, and the Ph.D. in three, if the student devotes his entire time to graduate study. Unusually capable students may obtain fellowships or teaching assistantships which pay from $300 to $1800 per annum. The fellow may generally devote his entire time to study; the teaching assistant spends from three to twenty hours per week instructing students, and usually takes four, five, or even six years for his Ph.D. The graduate student in chemistry or chemical engineering pursues more advanced courses in these subjects, and in related sciences (physics, mathematics, thermodynamics, engineering, mineralogy, geology, biology, etc.). As a rule he devotes about one-third of his time to research or investigation on one topic which will be an original contribution to our knowledge of chemistry.

Nothing has been said about preparation for special fields. The undergraduate must have a broad training and a thorough foundation. He does not have time to specialize. The graduate student may major along special lines if he wishes. Nothing has been said about training for specific industries because the student does not usually know in advance to which industry he may be called. Even special preparation for government positions has been omitted as each announcement requires different training of candidates who plan to take the civil-service examinations.

Qualifications Necessary

The preparation and training necessary for the practice of chemistry were discussed in the preceding section. Some laboratories employ boys who have studied a little chemistry in high schools. These are pseudo-chemists, and rarely succeed at anything but routine operation under direction. The bachelor, beginning his work in a laboratory, must follow instructions carefully, but not blindly. He should consult his superior rather than depend on his own judgment in the beginning. Later he will be expected to rely on himself more and more. Unless the chemist is the first one employed in a plant, or industry, he would do well to observe and listen, acquiring experience before undertaking to bring about reforms. For research, and laboratory or plant supervision, more experience is necessary. This may be acquired in the plant by the bachelor who is promoted to the more responsible position. The doctor (Ph.D.) is given preference because of his more extensive training and assumed superior judgment. Degrees are not the only criteria. Personality plays an

important part. The bachelor with a good personality asset may pass the doctor. The attributes which lead to success are good health, including normal vision, hearing, and smell; neat and cleanly habits; good personal appearance and poise; willingness to work hard; ability to take responsibility, adapt one's self to conditions, get along well with others; self-confidence, good judgment, initiative; a good imagination, seeing things which can be done and doing them; an optimistic outlook on life and the determination to achieve the desired success despite difficulties. For the chemist nothing is more important than integrity. Chemistry is one of the exact sciences. Reports dare not be falsified. A mistake may be forgiven, but a falsified report is not tolerated.

Financial Return and Awards

Rates of compensation for scientific work generally compare with professional, rather than with commercial salaries. The bachelor usually begins to work at \$100 to \$150 per month; the master at \$150 to \$200; and the doctor at \$200 to \$300 per month. The Bureau of Vocational Education reports that average salaries in the Government service range from \$1164 to \$3904 (junior aids to senior chemists); in educational institutions, from \$720 to \$5650; and in industrial plants from \$1254 to \$10,138 per annum. Assuming regular promotion and no change in the nature of occupation, it is estimated that chemists in industry fare about as follows:

	Initial salary	After 5 years
Analysts (B.S.)	\$1800	\$2400
Plant Operatives	2000	3000
Research (M.S.)	2400	3000
Research (Ph.D.)	3000	4000

The chemist does not necessarily remain in the laboratory or plant. In the laboratory he may become chief chemist, and in the plant, foreman or superintendent. But he may decide to join the sales force and become valuable in business management. From chief chemist, superintendent, or business manager, he may rise to officer of the company. Financial return depends largely upon individual achievement. While averages are cited, there is really no upper limit to the amount which a successful individual may acquire and accumulate, especially through inventive genius, business acumen, and determination.

Chemists who enter the teaching profession, or pure research, are often idealists whose love of science is a first consideration, and financial return second. While some monetary awards are received, recognition and honors are the usual recompense for this idealism. Theodore W. Richards, of Harvard, received the Nobel prize, carrying with it the sum of \$40,000.

Dr. Richards is a member of the International Committee on Atomic Weights, a past president of the American Chemical Society and has had many additional honors. The late Ira Remsen was president of Johns Hopkins University and of the American Chemical Society; and Edgar Fahs Smith, ex-president of the University of Pennsylvania, also became president of the American Chemical Society.

Then there are the many graduate fellowships offered by technical societies, colleges, and universities. These carry awards of $300 to $2500.[1] The Mellon Institute of Industrial Research of the University of Pittsburgh has one hundred fellows receiving from $2000 to $7500 per annum. The average salary is $3600. Many of the fellowships listed in this paragraph permit incumbents to devote a part or all of their time to graduate study and research, leading to the M.S. or Ph.D. degree. The National Research Council offers fellowships paying upward of $1800. These are, as a rule, awarded only to holders of the Ph.D. degree. The work may be done in any institution properly equipped for the purpose.

Medals are awarded annually for superior work in pure and applied chemistry by the following societies.

Priestley Medal	American Chemical Society
Nichols Medal	New York Section, American Chemical Society
Grasselli Medal	New York Section, American Chemical Society
Willard Gibbs Medal	Chicago Section, American Chemical Society
Perkin Medal	American Section, Society of Chemical Industry
Cresson Medal	Franklin Institute
Longstreth Medal	Franklin Institute

Nor should one overlook the inducements that are even given to high-school students and college freshmen in the "Prize Essay Contest" of the American Chemical Society through the generosity of Mr. and Mrs. Francis P. Garvan. Sums as large as $1000 are awarded to successful competitors.

There are many other rewards for superior achievement. Only a few have been mentioned in the limited space that is available.

Advantages

Chemistry offers advantages that may be generalized as follows: It stimulates mental activity and enables the individual to develop a systematic and analytic turn of mind with a realization of the importance of accuracy. It encourages studious habits. One learns to appraise values and acquires business acumen. It has, indeed, been claimed by one of the leading financiers of the country, not a chemist, that every one intending to enter business should study chemistry for the mental training that it affords. The chemist, whether in education or business, has the privilege

[1] *Bulletin* **38**, National Research Council, 1923.

of associating with educated and interesting people. The importance of his accomplishments frequently brings him into contact with officers of the company, which contact often results in promotion to a more responsible and lucrative position. Chemistry is of real value to society, in fact, fundamental to man's welfare. It is engaged in the "preservation and restoration of health;" in the production and improvement of materials whose manufacture determines our comfort, affects our purses, marks the very progress of our civilization. Chemistry is in its infancy. What has been accomplished in the past is but a small fraction of that which is yet to be mastered. The lure which discovery holds is ever fascinating, a stimulus to go on, and on, and on. The professionally qualified chemist should have more opportunity for development than most engineers, as the scope of chemical science is much broader than that of physical science.

Disadvantages

The writer cannot see disadvantages, except for the physically weak, the unqualified, and the indolent. Hard work and constant study are essential here as in all other occupations. In some fields of chemistry there is an element of danger. As a rule, proper precautions eliminate or minimize the danger. Factories may at times be located in small towns and pioneer work may have to be undertaken in difficultly accessible places. These conditions are not peculiar to chemistry alone.

Extent of the Occupation

The 1920 census of the United States listed 32,941 chemists, of whom approximately five per cent were women.[2] This number probably includes some pseudo-chemists, or those not trained in colleges or universities. The Bureau of Mines in 1917 made a study of the distribution of chemists in various fields. This follows and serves as an approximate guide:

Acids, alkalies, and salts	1405
Alcohol and acetone	339
Ammonia oxidation	81
Analytical chemistry	3808
Barium compounds	208
Cement and lime	584
Coal, gas, tar, and coke	1294
Dyes and textiles	775
Electrochemistry	769
Explosives (high)	962
Explosives (black powder)	150
Fats and soaps	834
Fertilizers	844
Foods	1619
Glass and ceramics	262

[2] "Women in Chemistry," Bureau of Vocational Information, New York, 1922.

Inorganic chemicals	532
Nitrogen compounds (synthetic)	128
Organic chemicals (other than alcohol and acetone)	888
Paints and varnishes	577
Petroleum and asphalt	769
Pharmaceuticals	983
Pyrotechnics	42
Rubber and allied substances	494
Sugar, starch, and gums	592
Water, sewage, and sanitation	1035
Wood products	368
Metallurgical chemistry	494
a. Alloys, ferrous	323
b. Alloys, non-ferrous	360
c. Aluminum and magnesium	127
d. Antimony, bismuth, cadmium	54
e. Chromium and manganese	82
f. Copper	379
g. Gold and silver	337
h. Iron and steel	1415
i. Lead	209
j. Mercury	25
k. Nickel and cobalt	68
l. Platinum metals	75
m. Radium and uranium	99
n. Silicon and titanium	89
o. Zinc	255
p. Other metallurgy	126
Professors and instructors	1285
Miscellaneous	1130

a. 240 men not actually engaged in laboratory work but holding administrative positions, such as secretaries, presidents, and treasurers of chemical companies.

b. 157 leather chemists.

c. 116 research chemists.

d. A number of dentists, editors, physicians, chemical engineers, and consulting chemists.

The chemist supervises the entire domain of chemical technology. Engineers who supervise the field of physical technology depend on his assistance. The chemist is active in manufacture, the products of which for the past year in the United States alone were appraised at more than $40,000,000,000. With the ever-increasing importance of chemical industry, these already significant figures will grow larger and larger. Pioneer work in foreign countries, whose technical development is just beginning, offers incalculable possibilities.

National Associations

Every chemist and chemical engineer should join the American Chemical Society, which now has 14,500 members and 69 local sections in 39 states.

The various journals which this Society sends to its members constitute, as a whole, the most valuable literature published by any technical society. A knowledge of current literature is essential to advancement. In fact one should not undertake a research problem until he has searched the literature to see what has already been accomplished in the particular field. The social and intellectual contacts afforded at conventions of technical societies constitute an important asset.

Other national organizations are: American Association for the Advancement of Science, American Association of Cereal Chemists, American Association of Textile Chemists and Colorists, American Ceramic Society, American Concrete Institute, American Electrochemical Society, American Electro-platers' Society, American Gas Association, American Institute of Baking, American Institute of Chemical Engineers, American Institute of Chemists, American Institute of Fertilizer Chemists, American Institute of Mining and Metallurgical Engineers, American Iron and Steel Institute, American Leather Chemists' Association, American Oil Chemists Society, American Pharmaceutical Association, American Petroleum Institute, American Society for Steel Treating, American Society for Testing Materials, American Society of Biological Chemists, American Waterworks Association, American Wood Preservers' Association, Asphalt Association, Association of Official Agricultural Chemists, National Academy of Sciences, National Wood Chemical Association, Portland Cement Association, and Technical Association of the Pulp and Paper Industry. No attempt has been made to list foreign societies because the writer feels that American chemists should join American societies first. Many of the foreign societies and their publications are also important.

For social as well as technical advantages, membership in the Chemists' Club of New York City is desirable. One has an opportunity to meet some of the leading chemists of the country at this club, and can live there and make the club his headquarters while in the East. For those residing outside of the New York district, a reasonable non-resident membership rate has been established.

Acknowledgment

It almost goes without saying that statistical material is the result of collaboration. The writer gratefully acknowledges information obtained from the publications of the Bureau of Vocational Information, U. S. Census Bureau, U. S. Bureau of Mines, National Research Council, and Mellon Institute of Industrial Research.

The patient investigation and accurate methods required to obtain desired results in the school of experimental and technical science, cannot fail to impress, refine, and ennoble the characters of those who work in this direction.—SIR WILLIAM MATHER

A PERSONNEL STUDY OF CHEMISTS IN THE UNITED STATES*

C. J. HO, TEACHERS' COLLEGE, COLUMBIA UNIVERSITY, NEW YORK CITY

Considerable concern is felt among scientists over the problem of recruiting able and apt young men and women for service in the fields of science. The National Research Council has felt that some vocational guidance ought to be exerted in this direction and has made an initial gesture by preparing a series of "Career Pamphlets" designed to inform young people about the opportunities in various scientific fields.[1]

If information about vocations is to be given effectively, however, it must be based on scientific investigations into the personnel of the vocations. The need is not for facts about chemistry, for example, but about the vocation of the chemist. The only way to obtain such facts is to investigate the vocational histories of a number of chemists, amass facts regarding their vocational progress, and present these in statistical form as indices of the vocational route over which a newcomer in the field may expect to travel.[2]

Material for such a study was made available by the Research Informa-

* The writer is greatly indebted to Dr. Harry D. Kitson for his careful direction in this investigation.

[1] The National Research Council, Washington, D. C., Division of Educational Relations, Vernon Kellogg, *Chairman*.

Career Pamphlets:

1921 Geolcgy as a Career, James F. Kemp
1922 Anthropology as a Career, Clark Wisslor
The Field for Chemists, Wilder D. Bancroft
Geography as a Profession, Homer P. Little
Research in the Field of Agriculture, A. F. Woods
Electrical Research Viewed as a Career, William Sparagen
1923 Agricultural Research as a Career, E. D. Ball
Forestry as a Career, Henry S. Graves
Zoölogical Research as a Career, C. E. McClung
Mathematics as a Career, C. J. Keyser
Physics as a Career, George Walter Stewart
A Research Career in Astronomy, Paul W. Merrill
Psychology as a Life Work, Raymond Dodge, E. L. Thorndike, S. I. Franz, and W. V. Bingham
Research in the Medical Sciences, Frederick P. Gay
The Study of Life as a Thing Worth Doing, Albert L. Barrows
1924 The Research Career in Public Health, David L. Edsell
Industrial Research and Its Opportunities, John Mills
Civil Engineering as a Career, W. K. Hatt
Psychology as a Career, C. E. Seashore
1925 Botanical Research as a Career, John M. Coulter

[2] Harry D. Kitson, "The Scientific Compilation of Vocational Histories as a Method to Be Used in Vocational Guidance," Teachers College Record, September, 1926.

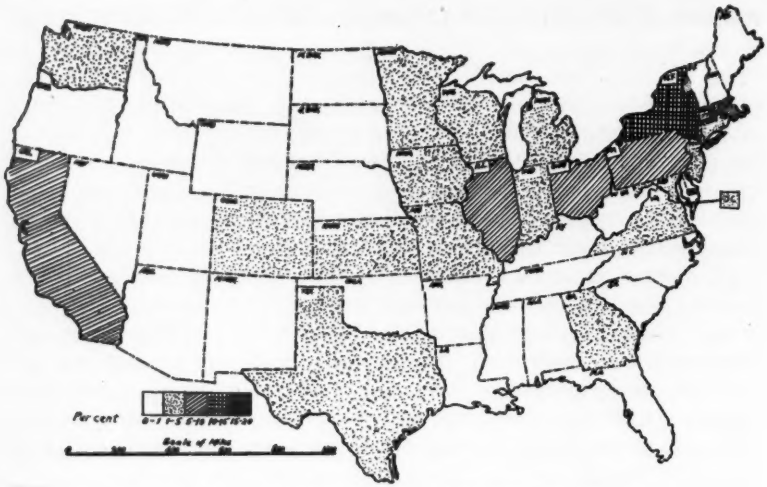


FIG. 1.—Geographical Distribution of Chemists (Teachers).

tion Service of the National Research Council who kindly permitted the use of their personnel records of about 1800 chemists in the United States. These include all the active members of the American Chemical Society and the chemists whose names are to appear in the forthcoming edition of the "American Men of Science." Only the records of men are here

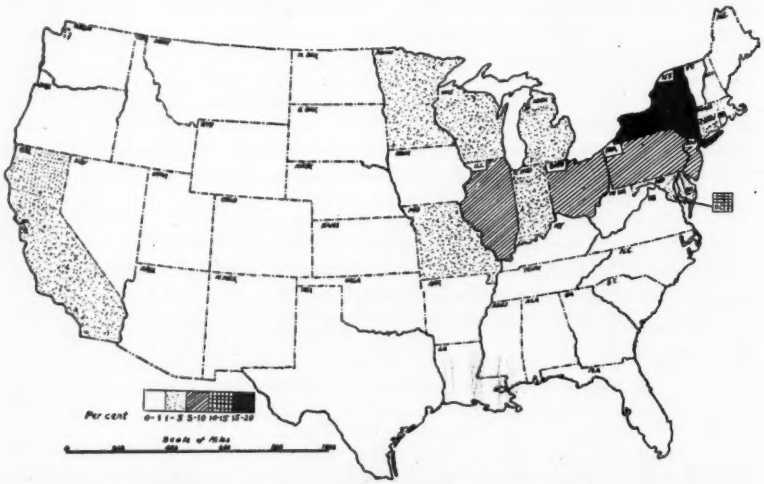


FIG. 2.—Geographical Distribution of Chemists (Non-Teachers).

compiled. The women are being separately studied by Miss Lycia Martin of Teachers College, Columbia University. The total number of chemists included in the study is 1799. They have been divided into two groups, teachers and non-teachers, numbering 829 and 970, respectively. They have also been studied as to age, academic preparation, location, branch of chemistry in which they are engaged, and rate of progress in school and in vocation.

Geographical Distribution

Table I and Figs. 1 and 2 show the geographical distribution of the chemists. It will be noted that New York State leads in both teachers and non-teachers. This is to be expected since this state has large numbers of industries and educational institutions. The District of Columbia comes next with respect to non-teachers, a reflection of the number of chemists in government service. California, Connecticut, Delaware, Illinois, Massachusetts, Michigan, Minnesota, New Jersey, Ohio, Pennsylvania, and Wisconsin are among the first ten states containing chemists. In general the Eastern and Mid-western states claim more chemists than the Southern and Western states.

TABLE I

GEOGRAPHICAL DISTRIBUTION OF CHEMISTS

Teachers		Non-Teachers	
State	Per cent	State	Per cent
New York	11.9	New York	20.6
Massachusetts	8.6	Dist. of Columbia	11.2
Pennsylvania	8.1	Pennsylvania	8.8
Illinois	7.8	New Jersey	8.7
California	7.1	Illinois	8.6
Ohio	5.3	Ohio	5.8
Connecticut	4.0	Massachusetts	3.5
Wisconsin	4.0	California	3.4
Minnesota	2.8	Michigan	3.4
New Jersey	2.8	Delaware	3.0

Age

As will be seen in Fig. 3, the modal age of teachers is 39; the distribution of ages of non-teachers is tri-modal—37, 38, and 39. But the fact that the median age of teachers is 46, while that for non-teachers is 44, seems to indicate that the teachers as a whole are slightly older than the non-teachers.

Academic Preparation

Table II shows that about 90 per cent of these chemists have obtained the Bachelor's degree, the median age being 23; 50 per cent obtained the Master's degree, the median age being 25; 79 per cent have the Doctor's degree, having obtained it at the median age of 28. Degrees are more

TABLE II

ACADEMIC PREPARATION

Degree	Cases			Per cent			Median Age				
	Teachers	Non-Teachers	Total	T	N	Total	T	N	Total	Q_1	Q_3
Bachelor's	767	842	1609	92.5	86.8	89.4	23.2	22.9	23.0	21.2	24.6
Master's	475	431	906	58.0	44.4	50.4	25.5	25.0	25.3	23.3	28.3
Doctor's	668	557	1225	80.6	57.4	68.9	28.5	27.4	27.9	25.7	31.3

frequent among the teachers than among the non-teachers, particularly the Doctor's degree, which is held by 80 per cent of the teachers and by only

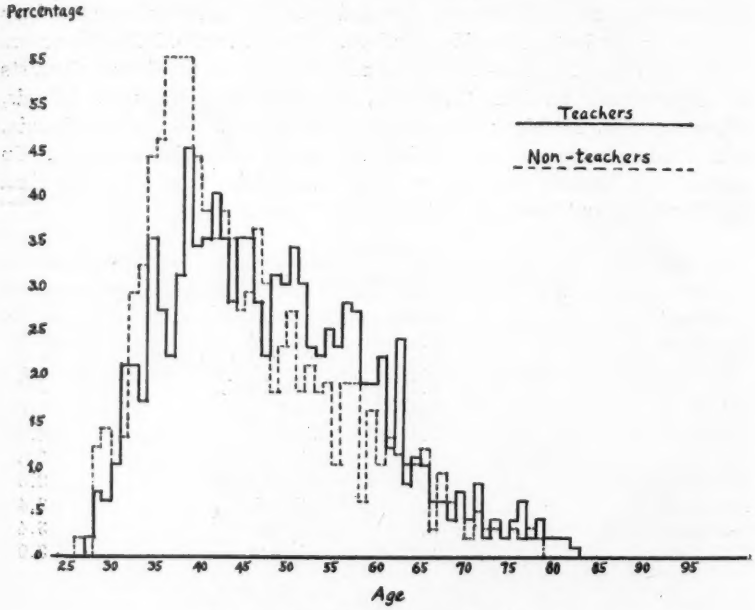


FIG. 3.—Age Distribution of Chemists.

57 per cent of the non-teachers. The latter group took the various degrees at a slightly earlier age than did the teachers.

Marital Status

Forty-two per cent of these chemists are married—48 per cent of the teachers and 36 per cent of the non-teachers (Table III). It is generally observed that the pursuit for a higher degree often postpones the date of marriage or vice versa. Since a Doctor's degree seems to be an essential part of the preparation for teaching, a further analysis was made, in the

TABLE III

MARITAL STATUS

	Cases	Per cent married	Median age	Q_1	Q_3
Teachers	401	48.4	28.2	26.0	28.2
Non-teachers	348	35.9	27.8	25.7	30.8
Total	749	41.6	28.0	25.9	31.0

case of the teachers, of the relation between the age at attainment of the Doctor's degree and the age at time of marriage. The results of this study are shown in Table IV. About 17 per cent of the Doctors took the degree

TABLE IV

RELATION BETWEEN MARRIAGE AND DOCTOR'S DEGREE IN THE CASE OF TEACHERS

	Cases	Per cent of doctors	Per cent of marriages	Median age of doctors	Median age of marriage	Age of professorship
Degree before marriage	115	17.2	28.7	26.6	30.4	32.9
Marriage before degree	128	19.2	31.9	31.8	26.6	33.7

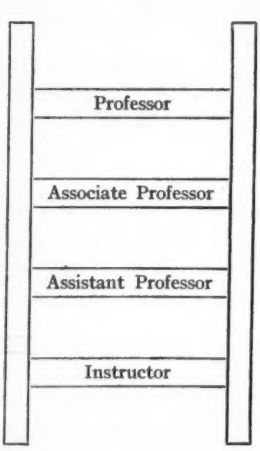
before marriage. They received the degree about the age of 26 and postponed their marriage about four years, until the age of 30. About 19 per cent of the Doctors married before taking the degree. Married at the age of 26, they took the degree at 32, six years later than the age at which their unmarried colleagues took it. From these figures we might advise a young man that if he marries before taking his Doctor's degree the chances are that he will be delayed in taking his degree about 6 years. If he takes the degree before marrying, he will probably delay the latter event, though only about four years. For a measure of the vocational effectiveness of these two procedures, we examined the ages at which the same persons became full Professors. It was found that those who took the degree before marriage attained the Professorship at the age of 33, while those who married before receiving the degree were elected Professor on the average at 34. This difference of less than one year, when compared with the error of difference, is so small as to be insignificant. Accordingly the present figures give no light regarding the relative efficiency of the two procedures.

Vocational Ladder for Professors of Chemistry

A young man who is desirous of teaching chemistry in an institution of higher education is interested to know what may be his fortune in this field. He is aware that he will have to pass through several ranks—Instructor, Assistant Professor, Associate Professor—before he reaches the full Professorship. But he would like to have more exact information showing how rapidly he may expect to advance. Such figures can be obtained only from a study of the vocational histories of persons who have

already attained the goal. Among the chemists included in this study were 483 with the rank of Professor. A compilation of their academic histories was made with results as shown in Fig. 4. Here it is seen that 237

FIGURE 4 VOCATIONAL LADDER FOR PROFESSORS OF CHEMISTRY



	Median age	Q_1	Q_3	Range	Cases	Per cent
Professor	33.2	29.2	38.1	20–54	483	100.0
Associate Professor	32.0	29.0	35.1	22–45	100	20.7
Assistant Professor	30.4	28.0	33.4	21–43	164	34.0
Instructor	26.2	24.4	28.1	18–42	237	49.1

or 49 per cent started as Instructors at the age of 26; 164 or 34 per cent were Assistant Professors at 30; 100 or 21 per cent were Associate Professors at 32; and they became Professors at 33. From these figures we can advise a young man that if he becomes a college teacher he may expect to progress at about that rate. Of course, rates of promotion vary slightly from one institution to another. They are slower in a few of the largest universities.[3] Still, the figures here given probably represent conditions in the majority of colleges throughout the country.

Classification of Non-Teachers

A young man who wishes to be a chemist but is not interested in teaching would like to know what might be his field of work as a non-teacher. An attempt has been made to answer this question by a classification of the non-teachers in the present group. The classification was made in two ways: according to the nature of positions held and according to the branches of chemistry represented. In spite of the difficulties invariably attending the making of classifications a fairly satisfactory arrangement was concluded with results as shown in Tables V and VI. Here it is seen that almost 40 per cent of the non-teachers are engaged in business estab-

[3] Harry D. Kitson, "Relation between Age and Promotion of University Professors," *Sch. and Soc.*, **24**, 400–4 (Sept. 25, 1926).

TABLE V

CLASSIFICATION OF NON-TEACHERS ACCORDING TO POSITION

Position	Cases	Per cent
Business		
Specialists	195	20.7
Research Workers	109	11.6
Executives	73	7.8
Proprietors	5	0.5
Research Workers in Private Bureaus	200	21.3
Government		
Federal	109	11.6
State	21	2.6
City	15	1.6
Specialists, including Consulting Chemists	119	12.6
Experimental Stations		
Specialists	22	2.3
Research Workers	9	1.0
Executives	8	0.9
Colleges		
Research Workers	22	2.3
Executives	3	0.3
Editors	10	1.1
Medical	10	1.1
Organizations	6	0.6
Miscellaneous	4	0.4
	941	99.9

lishments, probably manufacturing; 14 per cent in government service; the rest are employed by private research bureaus, experimental stations, and the like. A large number of the unspecified specialists are consulting chemists. The total number of consulting chemists is possibly 25 per cent.

It was not possible to determine from the records the minute branch

TABLE VI

CLASSIFICATION OF NON-TEACHERS ACCORDING TO BRANCH

Branch	Cases	Per cent
Biochemistry	232	31.6
Organic	200	27.3
Physical	93	12.7
Inorganic	74	10.1
General	42	5.7
Analytical	42	5.7
Metallurgical	23	3.1
Industrial	22	2.9
Literary	2	0.3
Others	2	0.3
	732	99.9

of chemistry in which each man specialized. Of 732, however, the largest group, 30 per cent, are engaged in the field of biochemistry; 27 per cent in organic chemistry; 12 per cent physical; and 10 per cent inorganic.

Conclusion

In this investigation we have used a new technic of studying a vocation—that of examining the vocational histories. We have made such an investigation of the leading chemists of the United States. The results give a partial picture of the type of men who are engaged in this profession. They appear to be about 40 years old, concentrated in the heavily populated parts of the country. About 40 per cent are teachers and 60 per cent non-teachers. This indicates that there are probably greater opportunities in the latter field; probably the greatest number are in business; in fields that might be designated biochemistry and organic chemistry.

The majority of these chemists have the Doctor's degree. The ages at which they took their degrees are: Bachelor's, 22; Master's, 25; and Doctor's, 28. Forty-two per cent are married.

The "typical" Professor of chemistry reached the various levels of the academic ladder at the following ages: Instructor 26, Assistant Professor 30, Associate Professor 32, and Professor 33.

These facts are of value in several respects. As material for use in vocational guidance, they enable a vocational counselor to give concrete information to a young man who seeks advice before planning his career. To chemists already at work the figures furnish bases on which they may direct their efforts more intelligently. To those interested in the advancement of the profession such facts give information about the status to which the profession has already advanced. It might be mentioned that similar investigations are being carried on by the writer in eleven other scientific fields. The results will give information about each of these fields and will permit comparisons between them.

Experts Remove Antiseptic Stains. The gay-colored mercurochrome that has replaced the homely brown of iodine as an antiseptic on the shelves of the family medicine cabinet produces a stain difficult to remove when spilled on clothing. Research undertaken at the U. S. Bureau of Standards shows how the refractory coral color can be made to disappear if taken early enough.

Applications of benzaldehyde followed by 25 per cent hydrochloric acid have been found to work very well on fresh stains on silk. It is well, say the experts in charge of the tests, to follow up this treatment by sponging with alcohol and then with water.

Mercurochrome stains should be taken out before a garment goes through the process of being dry cleaned because when mercury comes in contact with sulfur it forms a black insoluble compound that cannot be removed from the fabric. Sulfur is encountered in dry-cleaning plants either in the cleaning solvents or free in the air around gas burners.—*Science Service*

RECENT ADVANCES IN TEACHING ELEMENTARY CHEMISTRY*

WILHELM SEGERBLOM, PHILLIPS EXETER ACADEMY, EXETER, N. H.

Recent advances in the teaching of elementary chemistry center around the following activities: (1) the American Chemical Society, (2) the College Board, (3) new textbooks, (4) new kinds of texts, (5) a study of the art of teaching chemistry, (6) activities of high-school chemistry teachers, and (7) summer courses for teachers of chemistry.

The Division of Chemical Education of the American Chemical Society has been actively interested since its inception about five years ago in the three-fold problem of (1) high-school chemistry, (2) college freshman chemistry, and (3) the correlation between the two. The Division's main committee, called the Committee of Chemical Education and composed of high-school chemistry teachers, college chemistry teachers, and technical chemists, has drawn up "A Standard Minimum High-School Course in Chemistry." This Minimum Course was submitted at the September, 1923, meeting of the Association, adopted tentatively, and printed in *School Science and Mathematics* and in *Industrial and Engineering Chemistry*. It was brought before about thirty thousand high-school chemistry teachers throughout the country with requests for criticism. New England teachers turned in some very timely and helpful suggestions. Acting on all these, the Committee revised the List of Topics to put it in accord with the majority opinion of those most concerned, and the revised course was published again in May, 1924. Since then numerous comments have been made that the List of Topics was still too long. Consequently, at the Philadelphia meeting last September the Committee recommended the deletion of several topics, and the recommendation was adopted.

The Committee realized from the first the wide divergence in content of high-school chemistry and has striven to list only the essential topics which are common to all localities so that the teacher may have time to develop those phases of the subject which are of local or seasonal interest. The Committee does not presume to say that the chemistry course should be the same in all high schools, but it does feel that all such courses should accomplish two things: (1) give the student an intelligent grasp of the minimum essentials and fundamental principles underlying the subject, and (2) start the mind to working in a logical and scientific manner. The Committee has all along felt that its best service was to ascertain what few topics from the vast number unfolding to us in our science were considered fundamental and to use what influence it might have to give the teachers the time necessary for developing other topics. This is far from making high-school chemistry a dry, standardized subject.

*Read before the Science Division of the Maine Teachers' Association, Oct. 29, 1926.

In those states where the high-school graduate does not step without examination into the state university, the College Entrance Examination Board wields a considerable influence in determining what shall be taught in the high school. The Board tries not to be dogmatic about this. Instead, it adopts as its definition in chemistry, as in other subjects, those topics which a commission, appointed by the Board and consisting of both high-school and college teachers, agrees upon as essential.

During the past two years the definition has been undergoing close scrutiny at the hands of a Revision Committee which considered its main function to be (1) to select those topics which are fundamentally essential, (2) to eliminate time-honored topics on which it was difficult to ask questions, (3) to reduce the amount of ground to be covered by the examination to such an extent that the teacher can develop his course with extra topics suitable to his locality and pupils. In this way it was hoped that the college preparatory student would get the so-called "interesting" parts of chemistry usually included in the course given to the non-college student. At the same time the non-college student was likely to get a knowledge of the fundamental principles. Thus it is hoped that the ninety per cent who do not go to college will get a better idea of the meaning of chemistry and will take with them from their high-school chemistry enough of the subject to enable them to understand and to cope better with the problems they meet in their daily experiences. The new definition is not far different from the American Chemical Society high-school course.

High-school chemistry texts have in the past been dominated by the college-entrance requirements. It was also only natural that at first all of the texts should be written by college teachers who have never taught in the high school. The next step was a high-school text written by high-school teachers to meet the college entrance requirements. Finally we come to the stage where the occasional high-school chemistry teacher stands out above the general run of chemistry teachers and, relieved of having to direct athletics or teach two, three, or four subjects not related to chemistry, is therefore able to study the job of presenting elementary chemistry to his pupils most efficiently. He finds that teaching high-school chemistry is far from teaching the subject out of textbooks, and he gets an insight into the peculiarities of the job that no college teacher could ever hope to get. When such a teacher brings out a chemistry text, it is safe to assume that he is expressing the results of some real research into the problem of teaching high-school chemistry. Several such books have appeared during the past few years, notably one from the Atlantic Coast, another from the Middle West, and a third from the Pacific Coast. These show that the authors clearly realize that teaching high-school chemistry in the best way is far from administering an abbreviated

college freshman course in inorganic chemistry to their pupils. The texts show that the authors have studied carefully the best topics to present, have tried out various methods of presenting these, and have developed better teaching devices.

New kinds of tests are a direct result of the study of how best to present elementary chemistry. Numerous kinds have appeared recently: *e. g.*, the plus and minus test, the true and false test, the incomplete sentence test, the "choose one" test, the placement test, the equation test, and probably several others. Some of them go by the names given above and some bear the name of the originator. Many of these are admirable so far as they go, but unfortunately some of them do not go very far. For occasional use they have their value but they must be used with caution. Too much seems to be claimed for some of them. Some seem to be designed primarily to shorten the time of the teachers used in correcting them. Laying a strip of paper appropriately marked with pluses and minuses alongside of the pluses and minuses placed by the pupil before separate statements in a printed list can hardly give the teacher the same impression of the pupil's knowledge that reading full-sentence statements does.

It seems a doubtful policy to put incorrect statements in print before a student, as it is hard enough to get some students to read a correct statement and then repeat it correctly. Another danger in true and false tests is that sometimes a question may be correctly answered by either of two diametrically opposite answers according to the view of the pupil. Much work must plainly be done on these tests in order to make them thoroughly satisfactory measures of a student's achievements. Certain equation tests are valuable because they embody a careful search of texts in common use to determine what equations are generally found in the texts.

One of the best types of short tests that I have heard of consists of short, definite questions, each of which must be answered by one short but complete sentence.

A study of the art of teaching chemistry has been touched on under texts by high-school teachers who have studied closely how best to teach chemistry. This art is being studied critically—on the one hand by investigating professors in certain teachers' colleges, and on the other hand by those high-school teachers who are fortunate enough to work under principals and superintendents who are awake to the possibilities of science teaching in high schools.

In certain teachers' colleges, investigating professors are doing valuable work in studying the problem. The work of S. R. Powers, at Teachers' College, New York City, should be mentioned in particular. That this sort of testing must be most carefully done is shown by the fact

that even Powers slipped a little in some of his investigations. He sought to ascertain how successfully high-school chemistry was being taught by selecting a limited number of schools in a few states and testing the scholars by means of questions which served to test the memory in many cases rather than the ability to think chemically. The danger here is that any conclusions drawn may easily be thought by some to apply to the whole field more accurately than they warrant.

Powers has investigated very carefully the technical terms used in elementary science and finds some startling results:

(1) Of 1900 unusual terms found in two very widely used chemistry texts, nearly 30% were used less than three times, and only 12% were used in both books.

(2) Next to biology, chemistry uses the largest number of uncommon words.

(3) More than half the uncommon technical words used in high-school science texts could be eliminated without loss to teacher or pupil.

Lists of words and periodical articles reveal much more work done along this line by Powers.

In line with this the Committee on Chemical Nomenclature of the Division of Chemical Education of the American Chemical Society is working on terms which might be stricken out of high-school chemistry. It is also advocating more accurate definitions for the terms actually used. Dr. A. P. Sy, University of Buffalo, is eager to get opinions of teachers on this point.

Visual Education is entering the field of high-school chemistry. The Division of Chemical Education has a committee working on this and their reports may be expected before long.

A very helpful device for the teacher is to take the chemistry class through local industrial plants and to explain the chemistry involved in order (1) to make chemistry more real to the students, (2) to arouse their interest, and (3) to show the vital relation of the subject to national prosperity.

As to content implied in better teaching these items might be mentioned. Teach general principles so far as possible and let each new experiment or reaction illustrate some general principle. H. F. Davison says that lecture experiments should "drive home general methods and general principles as far as possible" instead of being merely spectacular.

Further, teaching too many isolated facts leads to confusion. Therefore, group the facts as much as possible. Use the Periodic System if you love this tool. Some think the electromotive series or displacement series a better aid in that it teaches or classifies among other things (1) the occurrence of metals as free or combined, (2) general methods of metallurgy, and (3) the reactions between a metal and acids.

If you teach much on metals, group the metallurgy around the four general methods of extraction, instead of letting the student get the idea that each metal has a method of extraction all its own very different from that of other metals.

Here are some items which the wide-awake teacher will probably bear in mind: (1) laboratory work to accompany the textbook for, unfortunately, there still exist schools where chemistry is taught without laboratory work, (2) the proper order of laboratory and textbook work, (3) the proper proportion of time devoted to each, (4) the most appropriate and efficient selection of experiments to avoid play in the laboratory and to form the proper underpinning for a body of chemical knowledge, (5) inclusion of the right amount of quantitative experiments, (6) more educative guidance by the teacher in the laboratory, (7) sufficient time for the teacher to prepare for the laboratory work, (8) development of scientific methods of thinking or reasoning rather than allowing the laboratory period to be a period of mechanical test-tubing, (9) giving full clock-hour credit to both student and teacher for the laboratory period, because an hour honestly and faithfully spent in laboratory work and properly supervised, guided, and quizzed is worth an hour to both teacher and pupil, (10) a fair inspection of the notebook, and (11) the recognition that solid chemical knowledge is gained from personal contact with chemicals and their reactions followed by proper digestion of the facts thus obtained.

Teachers of elementary chemistry are associating themselves more than ever with organizations of chemistry teachers, are investigating methods and devices with a more critical mind, and are taking an active part in crystallizing their findings into working procedure.

Chemistry teachers' organizations are now usually well developed. Nearly every state in the Union has such an organization, formed sometimes in connection with the state teachers' association, sometimes associated with the local sections of the American Chemical Society, or as in New England, as regional divisions of some parent society such as the New England Association of Chemistry Teachers. The help gained by the exchange of ideas in such an organization cannot be estimated. These ideas may well deal with some of the topics just mentioned under the art of teaching.

Summer courses for chemistry teachers have undergone radical changes from the former intensified résumés of inorganic chemistry to (1) a consideration of methods, devices, and procedures, which have actually been tried and found to work in the hands of the high-school teacher, (2) a comparison and sifting of these, and (3) a step toward making the teaching of elementary chemistry a profession by itself.

Some of the topics considered in recent summer-school courses on how

to teach chemistry are: (1) desirability of drawing information out of the student instead of telling him, (2) use of questioning in connection with lecture experiments, (3) emphasis on general principles rather than on isolated cases, (4) energy and the rôle it plays in chemical reactions, (5) grouping data around the electromotive series, (6) use of comparison in studying certain substances: *e. g.*, oxygen and sulfur, nitrogen and phosphorus, (7) selecting quantitative experiments with reference to the ability of students to get worthwhile results, (8) use of brief, simple, essential questions, (9) avoidance of long, vague, trivial questions, and those requiring yes or no answers, (10) qualities that make for effective teaching: *e. g.*, not too close dependence on the text, knowing more than you are to teach, carrying on experimental work of your own of which the students have knowledge, exercise of fairness, patience, and leadership, (11) better definitions of chemical terms, (12) teaching the preparation of such acids as hydrochloric, hydrofluoric, nitric, and hydrogen sulfide as one topic, (13) general methods of the preparation of soluble salts, (14) general methods of the preparation of insoluble salts, (15) advantages and disadvantages of starting with tangible or intangible substances: *e. g.*, with the metals or with the gases, (16) familiarity with good points in laboratory planning, laboratory equipment, and laboratory appliances, (17) books for the teacher, (18) books for the scholars, and (19) preparation of the teacher for the job of teaching high-school chemistry.

In conclusion, let me suggest that the most marked advances in the future will probably be due to the activities of the high-school teachers themselves coupled with a critical and broad examination of the methods in use and the results of the teaching as manifested in the kind of chemical information and scientific methods of thought carried out by the high-school students as they leave high school either to enter college or to take their places immediately in the non-college life of the community.

Helium Used to Fill Toy Balloons. Helium, the valuable non-inflammable gas used to keep huge dirigibles afloat, is being used to make toy balloons safe for small boys. In certain cities nervous mothers have caused the passage of a law prohibiting the use of inflammable gases for inflating toy balloons, with the result that they are now being inflated with helium. The price of the balloons is somewhat higher but mothers in those cities have one less cause for worry. Requests for helium to be used in this way indicate that this may prove to be a rather important commercial field for helium, according to the U. S. Bureau of Mines.

Helium is being used experimentally in a number of ways. It is being experimented with by electrical companies for the cooling of generators and motors and for the filling of radio tubes. The success of helium in the treatment of caisson disease has encouraged other ventures with this gas in the field of medicine. It is now being tried out in the treatment of pulmonary disorders because of the fact that it is less irritating than oxygen. It is also being tried experimentally upon epilepsy.—*Science Service*

THE PLACE OF BIOCHEMISTRY IN THE HIGH-SCHOOL CHEMISTRY CURRICULUM*

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Until comparatively recent years, all the recognition biochemistry received in the chemical curriculum was a few lectures in organic chemistry concerned chiefly with materials used, formed or excreted by living organisms. But the chemistry of life was not content with the cramped quarters furnished by its chemical-biological parents and erected a house of its own. Another member of the chemistry family, a clever fastidious fellow with clean hands and a mathematical turn of mind, physical chemistry, helped considerably. With a great deal of respect for its many progenitors and realizing they were a jealous lot, biochemistry let them all contribute their own particular architectural ideas. The result was anything but a simple cottage. Grandmother organic insisted on a group of elongated, low-ceilinged, ill-ventilated apartments. She is never satisfied, always changing the design and even now her end of the house looks quite unfinished. Physical chemistry erected beautiful spires extending to the heavens. To the very tips these are covered with elaborately carved figures quite indistinguishable to most of the passers-by. The biology quarters are comfortable with each room neatly labeled. They seem to be hardly satisfactory, as the biologists are continually wandering all over the house, sometimes quite losing their ways. Without carrying this analogy much further, it might be said that this biochemical mansion is attracting a great deal of attention and even viewed with considerable admiration by many whose scorn had previously been ill concealed. But is it any place for a high-school student?

There are at least two considerations which argue against the introduction of any amount of biochemistry into high-school courses. The first is the lack of preparation on the part of the student for an understanding of the subject. The second is the undeniably crowded condition of the chemistry curriculum at present in the secondary schools.

The state of chemical and biological knowledge in the brain of the high-school student is embryonic and in the majority of cases will undoubtedly remain so. Nevertheless, there are certain phases of physiological chemistry which these boys and girls should be readily able to grasp without a thoroughgoing knowledge of the more advanced branches of chemistry. It is hardly necessary to be able to write the formulas for ten amino acids to get a conception of the building-stone structure of proteins. One need never to have heard of gamma sugars to realize the fact that the blood may contain more than ample quantities of glucose

* Presented before the annual meeting of the Washington State Association of Chemistry Teachers at Seattle, October 28, 1926.

yet the body be starving for the want of sugar. One is reminded of the plight of the Ancient Mariner with

"Water, water everywhere
And not a drop to drink."

The inspiration of the discovery of insulin and something of its significance in this connection can hardly fail to be appreciated.

Much has been said and written concerning the high-school chemistry curriculum. There is the problem of correlating it with college chemistry. The objectives of chemistry teaching have been analyzed and a faithful attempt made to bring the subject-matter presented in the secondary school into line with the purpose of such a course. But even the minimum course seems to comprise a world of material to be digested. Were the modern youthful appetite for hearty cerebral meals as keen as it is for knicknacks, the problem of high-school teaching might be more simple. It is doubtful if the student's chronic state of mental dyspepsia can all be laid at the door of a crowded curriculum.

From the mass of chemical subject-matter which might be taught in the high school, there must be some selection of a certain amount which best satisfies the objectives of the course. High-school chemistry is certainly not fulfilling its purpose if the point of view is taken that it is entirely preparatory in nature. For the large majority of the students it is the only systematic presentation of the subject they will ever get. Certain minimum essentials are necessary to the presentation of elementary chemistry whether it is to be followed by more advanced work or not. When these fundamental principles are well in hand, it is appropriate and essential that the applications of chemistry be introduced, as the report of the committee of Chemical Education of the American Chemical Society states, "to show the service of chemistry to the home, to health, to medicine, to agriculture, to industry, etc.—in a word, to show the the service of chemistry to the country," and I should add, "to the individual."

Considering the value of chemistry to the student, one might be so bold as to suggest that to be able to outline the essentials of a properly balanced and adequate diet is as important as the ability to describe two processes for the manufacture of sulfuric acid. Even a boy aspiring to be a chemical engineer should know that a lunch consisting of a hot-dog sandwich and a bottle of pop is hardly in accordance with our modern knowledge of nutrition. Such knowledge should have as much of an appeal to the boy as to the girl. The great emphasis placed on proper diet of athletes is an illustration which he can well understand. The positive features in the ration should be emphasized. It is not simply a matter of avoiding hot mince pie.

Finally, let us consider very briefly what rooms of the biochemical mansion can well be opened to the high-school student, at least for a peep. Most texts seem to devote at least a few pages to the discussion of foods. The foodstuffs—carbohydrates, proteins, fats, mineral salts, and vitamins—are mentioned together with some idea of the purpose of each class. Some texts, notably McPherson and Henderson and Black and Conant, present tables with information as to the proximate composition of certain food materials as eggs, milk, meat, etc. The essentials of an adequate diet should be emphasized with some idea as to the methods by which these requirements have been established. Furthermore, it is not enough simply to answer the question of how much food, but how much of what and why. Don Quixote said to Sancho Panzo, "Eat little at dinner and less at supper for the health of the whole body is tempered in the laboratory of the stomach." He might have said, "Seek salad for lunch and spinach for dinner for the health of the body depends upon more than meat and potatoes."

What happens to the food in its journey through the alimentary canal need not remain a total mystery to the student as far as his chemistry course is concerned. The characteristic cleavages in digestion can be easily presented and readily understood. What sort of substances are absorbed and transported by the blood and what is excreted could be profitably touched upon, without becoming lost in the more complicated field of metabolism or the chemistry of the changes in the tissues.

There gradually may develop in the student's consciousness, some appreciation of the significance of Lavoisier's words, "La Vie est une fonction chimique." If life itself is a matter of chemistry, what can be of more interest and importance?

"Ultra-soft" X-Rays Deadly to Bacteria. "Ultra-soft" X-rays, radiations that occupy an intermediate position between the invisible ultra-violet light that lies above the ordinary visible spectrum and the "harder" X-rays ordinarily used in surgery and scientific investigation, have been found to be a potent means for killing bacteria, according to Dr. W. Schepmann of Berlin. Their existence has long been known, Dr. Schepmann states, but their properties have never been thoroughly investigated, especially as concerns their physiological effects.

Ultra-violet rays kill germs in a few seconds, and they have long been employed as germicidal agents, but their penetration into water is so small that their usefulness has been limited. X-rays, on the other hand, have great penetration, but it takes hours for them to kill bacteria. The ultra-soft X-rays are intermediate in both penetration and rapidity of action. They do not penetrate so deeply as the regular X-rays, but they do pierce liquids far enough for practical purposes, and instead of hours they require only minutes for thorough sterilization.—*Science Service*

HISTORICAL ASPECTS OF ANALYTICAL CHEMISTRY IN THE UNITED STATES FOR THE LAST FIFTY YEARS*

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Fifty years ago chemists had available for quantitative analysis well-developed methods for gravimetric analysis, many of our best volumetric methods and also gasometric methods. Electrolytic methods of analysis were just beginning to be developed. Methods of determination of hydrogen-ion concentration were wholly unknown.

Gravimetric methods were highly developed and most commonly relied upon by the analytical chemist prior to 1876. One finds in Fresenius, for instance, directions for the determination of available oxygen in manganese dioxide. He treats the MnO_2 with oxalic acid and sulfuric acid, the oxalic acid being oxidized to carbon dioxide by the available oxygen of the manganese dioxide. He tells us to carry out the reaction in a weighed flask and note the loss in weight from the evolution of carbon dioxide and calculate the manganese dioxide from the carbon dioxide evolved, 88 parts of carbon dioxide corresponding to 87 parts of manganese dioxide. Volumetric methods have long since superseded this indirect and not very accurate gravimetric method.

Many of our most reliable gravimetric methods were devised before 1876 and are in use today, nothing better having been devised. The J. Lawrence Smith method of decomposing silicates for the determination of the alkalies was published in 1871.

Some notable improvements in gravimetric methods have been developed since 1876. Prof. F. A. Gooch published a description of the well-known Gooch crucible in 1878 in the *Proceedings of the American Academy of Arts and Sciences.*

In the year 1876, electrolytic methods of determining metals were just beginning to be used. While a great deal of work had been done on the electrolysis of metallic salts before 1876 it was of a purely qualitative nature. Walcott Gibbs was the first to open the field of quantitative electrolytic deposition of metals by publishing in 1864 the results of an investigation on the electrolytic determination of copper and nickel. The article also included a description of the method for the determination of silver and bismuth as metals as well as of lead and manganese as peroxides.

A year later Luckow published an article in which he stated that he had determined copper "by this method more than twenty years ago and as early as 1860 employed the electric current for the deposition of copper quantitatively in various analyses." It, therefore, appears that

* Read before the joint session of the Division of Chemical Education and Section of History of Chemistry of the A. C. S. at Philadelphia, Pa., September 9, 1926.

Walcott Gibbs was the first to publish a quantitative method for determining metals electrolytically while Luckow had made such determinations much earlier but for some reason not given had not published his results.

Luckow proposed the name electro-metal analysis for the new method of quantitative analysis. The first textbook published, giving a systematic account of the new system, namely, that of Dr. Alexander Classen, appeared under the title, "Quantitative Chemical Analysis by Electrolysis." It had soon developed that the term electro-metal analysis was too narrow, as acid elements could also be determined by the new method.

Luckow carried out very extensive investigations in this field. He pointed out that metals such as lead and manganese could be separated as peroxides, that the electric current could be used to separate metals such as copper and manganese from zinc, iron, cobalt, and nickel and that metals could be deposited and estimated from acid, alkaline, and neutral solutions.

Other European investigators developed various electrolytic methods. These included Fresenius and especially Alexander Classen and his pupils who worked at the Aachen School. We are particularly indebted to these workers for the method using solutions of the double oxalates.

Among American workers Walcott Gibbs continued work along this line and in 1883 published a method of electrolysis of metallic salts using a mercury cathode, a plate of platinum being the anode. By this method an amalgam of the metal was formed which could be dried and weighed. Many metals which did not form weighable films because the deposit was spongy or oxidized readily could be determined by this method. It, therefore, was a distinct and important advance over the older method. Gibbs showed that iron, cobalt, nickel, zinc, cadmium, and copper could be completely separated from solutions of their sulfates. The phosphates could be dissolved in sulfuric acid and the metal determined by this method.

In 1886 Luckow published an article confirming these conclusions particularly with reference to zinc. Numerous articles began to appear in the technical journals both here and abroad giving new methods or improvements in older methods for the electrolytic determination of the metals.

It seems that, in spite of these earlier publications, in 1876 electrolytic methods were practically unknown in even the leading university laboratories of the country. Even as late as 1887 these methods were but little used.

The first textbook giving, in convenient form, directions for the methods available was published in 1888 when Prof. William Hale Herrick's translation of the second edition of Dr. Alexander Classen's well-known text ap-

peared. This text devotes a great deal of space to a description of galvanic cells for the production of the necessary current for the electrolysis. Thermoelectric piles are also described. There are also cuts and descriptions of quaint old dynamos which were apparently then first coming into use. Fortunately, the means of producing the necessary electric current has advanced simultaneously with the development of the methods of electroanalysis and has enabled the analyst to employ more extensively these most excellent methods.

About 1880 Dr. Edgar F. Smith began the publication of the numerous articles on electrolytic analysis in which he has given the results of the work carried out in his now well-known laboratory at the University of Pennsylvania. This laboratory in the United States proved to be a fitting counterpart to Dr. Alexander Classen's laboratory at Aachen, Germany. In these and other laboratories the methods which had been outlined were perfected and standardized, while from time to time more fundamental discoveries were made.

Among the latter could be mentioned the development of methods for the more rapid precipitation of the metals. Rotation of the anode and cathode was found to reduce the time of deposition to a most astonishing extent. Dr. Smith tells us that the first thought of doing this came to him in 1901. The first publication seems to have been in June, 1903, in the form of a doctoral thesis by Dr. Exner.

About this time the gauze electrode came into use by which the time of deposition could be very much reduced largely because very heavy currents could be used and the gauze electrode permitted circulation of the electrolyte.

A great variety of shapes of electrodes, dishes, cones, cylinders, etc., was tried out by the many workers who adopted the new method of determination. By this time the electrolytic method of analysis has been extended to practically all the metals and many of the acid elements. For a limited number of elements it has become standard practice and is at present in universal use.

Volumetric Methods of Analysis

Long before 1876 the principles of the volumetric method of analysis had been worked out. There were available for the analytical chemist methods in acidimetry and alkalimetry, oxidation and reduction such as potassium permanganate and potassium bichromate as well as some precipitation methods such as silver chloride with chromate as indicator. The improvements during the past fifty years have consisted in refining and standardizing many of these methods.

We find, for instance, that while the normal system of making up standard solutions had been proposed by Griffin and Ure and was in general

use that considerable confusion arose because some chemists used molar solutions instead of solutions based on the hydrogen equivalent. As late as 1890 Sutton, in his textbook on volumetric analysis, urges the general adoption of the hydrogen standard and points out the confusion which would result if, for instance, a normal solution of caustic potash contained 56 grams of KOH while a normal solution of potassium carbonate contained 138 grams of K_2CO_3 which would have twice as much potash as the caustic potash solution.

With reference to the volumetric apparatus in use fifty years ago it is interesting to note that the English system had been proposed and was in use to a certain extent. 10,000 grains was the standard of volume. This is equal to 1/7th of a gallon or a little over a pint. Side by side with this unit, the metric system was also used but even here there was considerable confusion with reference to the standard liter. According to the method proposed by Mohr a great deal of the volumetric apparatus in use was standardized by weighing water in air at room temperature. This gave a liter which was greater by 1.2 cc. than the true liter. Fresenius advocated the use of the true liter. In as much as these leaders of the profession disagreed, everyday working chemists sometimes had apparatus calibrated by one standard and sometimes by the other and very frequently had both. The work of Dr. Morse of the Johns Hopkins University and others in introducing methods and apparatus for calibrating volumetric apparatus and later the work of the Bureau of Standards has been effective in establishing the true liter as the standard for volumetric work. The improvement in the accuracy of commercial volumetric apparatus has been very noticeable.

Fifty years ago the analytical chemist had few indicators for acids and bases at his disposal. The list seemed to consist of litmus, cochineal, and turmeric. Titrations of sodium carbonate with acid were carried out using litmus at boiling temperature.

Sutton in his textbook on "Volumetric Analysis" in 1890 speaks of the azo colors as new indicators. In the same volume he gives the then recently published table by R. T. Thompson which set forth the acidity of the common acids, with methyl orange, phenolphthalein, and the then commonly used litmus. The great advantage of using the recently discovered indicators is emphasized in this volume.

I need not mention that hydrogen-ion concentration was not understood at that time nor were methods known for its determination. The varying sensitiveness of different indicators to various hydrogen-ion and hydroxyl concentrations was not worked out until methods for the determination of hydrogen-ion concentrations had been developed. The application of these methods to solutions used by present-day chemists and the interpretation of the results is a present-day problem. I prob-

ably do not overstate the situation when I affirm that there are a great many chemists today who are still quite ignorant of this most excellent modern development.

Among the important methods of analysis which have been developed during this period I may mention the well-known Kjeldahl method for the determination of nitrogen which was published in 1883 and adopted by the U. S. Association of Official Agricultural Chemists in 1887.

Gas Analysis

The chemist who undertook to make a gas analysis in 1876 had available the methods and applications which had been developed by the earlier chemists, particularly Bunsen. Results of high accuracy could be obtained by these methods but at the expenditure of a great deal of time. These methods were well adapted to scientific investigation but were far too slow for everyday use.

About this time the development of the modern rapid gasometric method had begun. The now well-known Orsat apparatus was devised in 1875. It was really an improvement on a preceding type first proposed by Regnault and Reiset in 1853 for scientific purposes. The first technical application of the apparatus seems to have been made in 1868 by Schlosing and Rolland. Because of improvements made by Orsat the apparatus has generally been known by his name. It seems to have rapidly come into general use and has been modified and improved in various ways. In 1882 Lunge added a contrivance for burning hydrogen by means of heated palladium asbestos or palladium wire. Dennis in 1912 and 1913 devised a special absorption bottle.

In 1877 the well-known Hempel apparatus appeared.

In 1885, 1888, and 1890 Lunge published articles on his well-known reduction tube by means of which the calculation of gas volumes to standard conditions was obviated. It will be seen from this that the methods and apparatus for rapid and convenient gas analysis came into use some 35 years ago and soon found extensive and general applications. Convenient textbooks on gas analysis such as that of Dennis were published about this time giving chemists ready access to the necessary information and directions.

The gas calorimeter was devised by Hartley in 1882 and was later modified by Juncker. This afforded a convenient apparatus for measuring the calorific power of gases.

The common absorbents for the ordinary gases seem to have been discovered very early. Chevrenel, in 1820, employed pyrogallol for the absorption of oxygen. Various investigators since that time have studied the behavior of this reagent with oxygen. The use of phosphorus for oxygen and caustic potash for carbon dioxide was known very early. The use of cuprous chloride solution for the absorption of carbon mon-

oxide does not seem to have been known until the early eighties. Hempel in 1877 suggested the use of palladium to absorb or rather oxidize hydrogen in the presence of methane.

The extended use of gasometric methods during the last few decades is clearly indicated by the very large number of articles published giving the results of studies of, the reactions involved, errors in the methods, new absorbents and innumerable modifications and improvements of apparatus.

Side by side with the publication and adoption into practice in chemical laboratories of these new methods, textbooks appeared giving complete and accurate directions for their use. The authors of these books also gave considerable original matter along the line of developments and refinements of the methods described, assisting materially in this manner in bringing the new methods into general use and raising the standard of accuracy of the scientific and commercial work done.

In 1876 almost the only text available was that of Fresenius, the first American edition having been prepared in 1869 by Samuel W. Johnson of the Sheffield Laboratory of Yale College. It is interesting to note that the old system of notation and nomenclature was retained in this translation on account of its having been used so long in the chemical literature as well as by the then active generation of chemists. In the second edition of Fresenius, prepared by O. D. Allen of Yale College in 1881, the new system was employed, the twelve intervening years evidently having served as a transition period.

About the same time the text by Francis Sutton on "Volumetric Analysis" appeared. By 1890 five editions of this work had been published and sold. In 1887 the first American edition of Classen's "Quantitative Chemical Analysis by Electrolysis" translated by Herrick appeared.

In 1885 a "Handbook of Technical Gas Analysis," by Clemens Winkler, translated by George Lunge, was published.

In these books and the various editions which followed, the analytical chemist had available authoritative handbooks on the then recently developed special branches of his science. Experience with these new methods soon showed that many of them were not suited for general use and that for a given analysis a judicious selection of gravimetric, electrolytic, gasometric, or volumetric must be made. Textbooks soon appeared based on such a selection. The earliest of these were a translation of Dr. Treadwell's well-known text by Professor Wm. T. Hall and the general textbook on "Quantitative Analysis" by Olsen, the first edition of which was published in 1904.

Among the other textbooks which have subsequently been published, mention may be made of that on "Analysis of Minerals" by Hillebrand of the U. S. Geological Survey which has undoubtedly had an important influence in improving the methods of analysis in this important field.

FUSED ELECTROLYTES—AN HISTORICAL SKETCH*

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In technical electrochemistry fused electrolytes play an important rôle. While the developments during the past 50 years have seemed enormous, the ground-work was laid in the same period when Volta discovered the "Pile." Current electricity had scarcely been made possible when the philosophers of that age studied its effects upon fused electrolytes.

The effects of the current on aqueous and non-aqueous solutions were very slightly understood at the time of Davy's fundamental work. Progress in the use of fused electrolytes came no more rapidly, nor more certainly than in other instances; there was just as much "philosophical haze" about the results in this case as in the use of any chemical process of the period. The clarification of the mechanism, from the qualitative standpoint, began very early in the study of the chemical action of the electric current.

Davy—Fused Electrolytes in Metallurgy

Even though Davy was forced by the managers of the Royal Institution to interest himself in a study of "Agricultural Chemistry," the observations of Nicholson and Carlisle[1] were powerfully impressed upon his mind, for we find in a laboratory notebook at the Royal Institution under the date August 6, 1800, the following: "I cannot close this notice without feeling grateful to M. Volta and Mr. Nicholson and Mr. Carlisle whose experience has placed such a wonderful and important instrument of analysis in my power." He at once sensed the connection between "galvanism" and chemistry.

The ground-work of electrolysis was cleared up by Davy in his first Bakerian Lecture, November 20, 1806,[2] and in his Bakerian Lecture of 1826.[3] In this latter lecture Davy felt that he had not, in the past, received quite the credit that was due him for priority in his work on electrolysis and cited references to show that the origin of electrolysis, or rather of electrochemistry, was to be found in Italy and England rather than in Germany, Sweden, and France.

The second Bakerian Lecture of Davy[4] is the first record of a fused electrolyte. He said:

> In the first attempts that I made on the decomposition of the fixed alkalies, I

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[1] *Nich. J.*, **4**, 183 (1801).

[2] *Phil. Trans.*, **97**, 1 (1807).

[3] *Ibid.*, **116**, 383 (1826).

[4] Davy, *Phil. Trans.*, **98**, 1 (1808).

acted upon aqueous solutions of potash and soda, saturated at common temperatures, by the highest electrical power I could command, and which was produced by a combination of Voltaic batteries belonging to the Royal Institution, containing 24 plates of copper and zinc of 12 inches square, 100 plates of 6 inches, and 150 of 4 inches square, charged with solutions of alum and nitrous acid; but in these cases, though there was a high intensity of action, the water of the solutions alone was affected, and hydrogene (*sic*) and oxygene (*sic*) disengaged with the production of much heat and violent effervescence.

The presence of water appearing thus to prevent any decomposition, I used potash in igneous fusion. By means of a stream of oxygene (*sic*) gas from a gasometer applied to the flame of a spirit lamp, which was thrown on a platina spoon containing potash, this alkali was kept for some minutes in a strong red heat, and in a state of perfect fluidity. The spoon was preserved in communication with the positive side of the battery of the power of 100 of 6 inches, highly charged; and the connection from the negative pole was made by a platina wire.

By this arrangement some brilliant phenomena were produced. The potash appeared a conductor in a high degree, and as long as the communication was preserved, a most intense light was exhibited at the negative wire, and a column of flame, which seemed to be owing to the development of combustible matter, arose from the point of contact.

When the order was changed, so that the platina spoon was made negative, a vivid and constant light appeared at the opposite point: there was no effect of inflammation round it; aeriform globules, which inflamed in the atmosphere, rose through the potash.

These globules, numerous experiments soon showed to be the substance I was in search of, and a peculiarly inflammable principle the basis of potash. I found that the platina was in no way connected with the result, except as the medium for exhibiting the electrical powers of decomposition; and a substance of the same kind was produced when pieces of copper, silver, gold, plumbago, or even charcoal were employed for compleating (*sic*) the circuit.

Soda, when acted upon in the same manner as potash, exhibited an analogous result; but the decomposition demanded greater intensity of action in the batteries, or the alkali was required to be in much thinner and smaller pieces.

The substance produced from potash remained fluid at the temperature of the atmosphere at the time of its production; that from soda, which was fluid in the degree of heat of the alkali during its formation, became solid on cooling, and appeared having the lustre of silver.

As in all decompositions of compound substances which I had previously examined, at the same time that combustible bases were developed at the negative surface in the electrical circuit, oxygene (*sic*) was produced, and evolved or carried into combination at the positive surface, it was reasonable to conclude that this substance was generated in a similar manner by the electrical action upon alkalies; and a number of experiments made above mercury, with the apparatus for excluding external air, proved that this was the case.

When solid potash, or soda in its conducting state, was included in glass tubes furnished with electrified platina wires, the new substances were generated at the negative surfaces; the gas given out at the other surface proved by the most delicate examination to be pure oxygene (*sic*); and unless an excess of water was present, no gas was evolved from the negative surface.

This long quotation from the epoch-making work of Davy shows him to have been a shrewd experimenter and thinker. When his plan of attack

was laid out there was little doubt as to the results settling the point in question.

At this time the current theory concerning the composition of the "earthy substances," *i. e.*, the fixed alkalies, was very much involved in the phlogiston theory. They were supposed to be metals *minus* phlogiston, or to consist of phosphuret of iron, or, in the cases of potash and soda, to contain azote. By his careful experimentation and reasoning Davy was able to show that the basis of potash, which he later named Potasium (*sic*), when treated with water re-formed the starting material, thus removing all doubt as to the ultimate composition of the substances. Then he went on and reasoned as follows:

> From analogy alone it is reasonable to expect that the alkaline earths are compounds of a similar nature to the fixed alkalies, peculiar highly combustible metallic bases united to oxygene (*sic*). I have tried some experiments upon barytes and strontites; and they go far towards proving that this must be the case. When barytes and strontites, moistened with water, were acted upon by the power of the battery of 250 of 4 and 6, there was a vivid action and a brilliant light at both points of communication, and an inflammation at the negative point. In these cases the water might possibly have interfered. Other experiments gave, however, more distinct results. Barytes and strontites, even when heated to intense whiteness, in the electrical circuit by a flame supported by oxygene (*sic*) gas, are non-conductors; but by means of combination with a very small quantity of boracic acid, they become conductors and in this case inflammable matter, which burns with a deep red light in each instance, is produced from them at the negative surface. The high temperature has prevented the success of attempts to collect this substance; but there is much reason to believe that it is the basis of the alkaline earth employed.

By this latter statement he anticipated his work on the alkaline earth compounds which was to result in the isolation of their respective "bases." Davy was not without imagination; but imagination alone could not suffice to solve the problem. He coupled his high-powered imagination with a resourcefulness in experimentation that enabled him finally to surmount the obstacles in the path towards his goal.

Having reported to the Royal Institute on November 19, 1807, his discovery of the metals potassium and sodium, he at once set himself to the resolution of the alkaline earths which he reported June 30, 1808.[5] After getting almost negative results and being in danger of seriously damaging his voltaic pile by the necessity of using nitric acid Davy attempted the use of fused mixtures as follows:

> A mixture of two-thirds of barytes and one-third of oxide of silver very slightly moistened was electrified by iron wires; an effervescence took place at both points of contact, and a very minute quantity of a substance, possessing the whiteness of silver, formed at the negative point. When the iron wire to which this substance adhered was plunged into water containing a little alum in solution, a gas was disengaged, which

[5] Davy, *Phil. Trans*, **98**, 333 (1808).

proved to be hydrogene (*sic*); and white clouds which were found to be sulphate of barytes, descended from the point of the wire.

The final isolation of barium is reported as follows:

Whilst I was engaged in these experiments, in the beginning of June, I received a letter from Professor Berzelius of Stockholm, in which he informed me that in conjunction with Dr. Pontin, he had succeeded in decomposing barytes and lime, by negatively electrifying mercury in contact with them, and that in this way he had obtained amalgams of the metals of these earths.

I immediately repeated these operations with perfect success; a globule of mercury, electrified by the power of the battery of 500, weakly charged, was made to act upon a surface of slighly moistened barytes, fixed upon a plate of platina. The mercury gradually became less fluid, and after a few minutes was found covered with a white film of barytes; and when the amalgam was thrown into water, hydrogene (*sic*) was disengaged, the mercury remained free, and a solution of barytes was formed.

Sodium, potassium, barium, strontium, calcium, and magnesium were isolated and studied. It is interesting to observe at this point that the metals had not been prepared in the pure state. Aside from the fact that no great reliance may be placed in Davy's numerical observation and deductions, the chemical properties show that he was dealing with alloys, all of which probably contained sodium and potassium.

In the same paper Davy reported his efforts to separate the earth metals from "alumine, silex, zircone, and glucine." He closes this lecture with,

....out of an immense number of experiments which I made....a very few only gave distinct indications of the production of any earthy matter; and in cases when earthy matter did appear, the quantity was such as rendered it impossible to decide on the species. Had I been so fortunate as to have obtained more certain evidences on this subject, and to have procured the metallic substances I was in search of, I should have proposed for the names of silicium, aluminium, zirconium, and glucium.

It is clearly seen that Davy was working with limited means and that though he probably had the largest Voltaic pile in the world it was nothing compared to the sources of the present day.

Faraday—Inorganic Electrolytes

Having briefly reviewed the early developments in the separation of metals from fused electrolytes, attention may well be directed to the electrolysis of inorganic salts in general, and, at the same time, to the theories which have been evolved from the results obtained. The winning of metals from fused electrolytes was entirely based on the work of Sir Humphry Davy and differed from it only in technic and choice of proper compounds and electrodes. Of course there was much done that was new and unique, but the massive deposition of metals was the phenomenon so strenuously sought.

The *Journal of the Royal Institution* for 1802, page 53, carries probably

the first record of a fused inorganic electrolyte when Davy stated that "dry nitre, caustic potash and soda are conductors of galvanism when rendered fluid by a high degree of heat." The next work was reported by Michael Faraday on the action of ice as an insulator with respect to the passage of the electric current. He found that though water conducted the current, as soon as there was a complete sheet of ice interposed between the electrodes, the current immediately ceased flowing.[6] Davy had already made the statement that "there are no fluids known except such as contain water, which are capable of being made the medium of connection between the metal or metals of the voltaic apparatus;"[7] though he was forced to recant this statement in his Bakerian Lecture of 1826.

Faraday immediately saw that there might be a connection between "the assumption of conducting power during liquefaction, and loss of it during congelation." There was no reason in his mind for the action of water being any different from the action of any other compounds which might respond to fusion. With fused lead chloride he at once showed that the powers of this compound to conduct the electric current were immediately lost as soon as the chloride solidified even though the platinum points used for contacts were only one-sixteenth of an inch apart. Reheating at once causes the current to resume. It is interesting to look over the list of compounds which Faraday studied.[8] "Water, oxide of potassa, protoxide of lead, glass of antimony, protoxide of antimony, oxide of bismuth; chlorides of potassium, sodium, barium, strontium, calcium magnesium, manganese, zinc, copper (proto-), lead, tin (proto-), antimony, silver; iodides of potassium, zinc and lead, protoiodide of tin, periodide of mercury; chlorate of potassa, nitrates of potassa, soda, baryta, strontia, lead, copper, and silver; sulphates of soda and lead" and many other compounds too numerous to mention are included.

One of the first facts he discovered was that in the instances of those substances which soften before they liquefy, they may become as soft as treacle without gaining the power to conduct, and, in the case of borate of lead, red heat and perfect fluidity had to be maintained in order to make it conduct with facility. In general, those substances which are already liquid at ordinary temperatures do not as a rule conduct even when heated. Boracic acid even at the temperature of the oxy-hydrogen flame did not gain in conducting power sufficiently to affect a galvanometer. It was also further shown that the power to conduct the electric current was accompanied by a decomposition when the current was passed.

The assumption of conducting power and a decomposable condition by liquefaction promises new opportunities of, and great facilities in, voltaic decomposition. Thus

[6] Faraday, "Exp. Researches," Vol. I, pp. 110–3.

[7] Davy, "Elements of Chemical Philosophy," p. 169.

[8] "Exp. Researches," Vol. I, pp. 113–9.

such bodies as the oxides, chlorides, cyanides, sulpho-cyanides, fluorides, certain vitreous mixtures, etc., etc., may be submitted to the action of the voltaic battery under new circumstances; and indeed I have already been able, with ten pairs of plates, to decompose common salt, chloride of magnesium, borax, etc., etc., and to obtain sodium, magnesium, boron, etc., in their separate states.[9]

Distortion of Faraday's Laws

In proving his two laws of electro-chemistry, *i. e.*, that "the chemical power of a current of electricity is in direct proportion to the absolute quantity of electricity which passes" and that in the case of ions "their electro-chemical equivalents are the same as their ordinary chemical equivalents,"[10] Faraday decomposed several inorganic salts with results that were in accord with the law.

It seems that there was no further study of these laws from the time of Faraday until 1900 when Lorenz was well along in his intensive study of fused electrolytes. This investigator with the aid of his assistants in a brilliant piece of research developed a new apparatus by means of which the diffusion of metal clouds, if not entirely prohibited, was at least cut to a minimum as far as distorting the quantitative results was concerned.[11] Before the advent of this apparatus the greater number of yields were by no means concordant with Faraday's Law, especially when the melting point of the salt was high. This apparatus is too well known to need description here.

Lorenz was able to show that when distorting influences were not present, Faraday's laws were valid, and that their validity as a rule was independent of the current strength and temperature in cases where reactions at the cathode were studied. In very few cases can the reactions at the anode be quantitative, as will be shown later.

Current Yields

This of course brings up the question of current yields at the cathode and anode. Lorenz[12] was able to identify the following conditions as regulating the current yields at the cathode:

1. Other conditions being the same, an increase in the temperature of the fusion lowers the yields and at the boiling point, no metal is deposited.
2. Faraday had shown, and then Lorenz proved more conclusively that the yields increased with the distance between the electrodes.
3. The deeper the electrode is immersed in the fusion, the lower the yields seem to be.

[9] *Op. cit.*, p. 119.
[10] *Op. cit.*, pages 231 and 245.
[11] Lorenz and Helfenstein, *Z. anorg. Chem.*, **23**, 255 (1900).
[12] Lorenz and Helfenstein, *loc. cit.*

4. As Bunsen[13] had shown the variation in current density sent the yields through a maximum point but Lorenz showed this not to be the case with all salts.

Very briefly, the phenomena which tend to lower the yields and to generally distort the successful prosecution of the electrolyses are:

1. Mechanical losses.
2. Vaporization of the metal by the use of too high a bath temperature.
3. Secondary chemical reactions at the electrodes.
   A. Formation of lower compounds at the cathode.
   B. Formation of higher compounds at the anode.
   C. General secondary reactions.
4. Metallic clouds or fogs.
5. Thermal convection currents which mix the primary products of the electrolysis.

Distortion Due to Secondary Reactions

Davy[14] discovered what he supposed to be a suboxide of potassium during his study of the cathodic deposition of potassium from fused potassium hydroxide. Sub-halides of Rb and Cs were found by Kirchoff and Bunsen.[15] Frary[16] seems to have isolated a sub-oxide of Mg which was formed as a cloud in the electrolysis of fused $MgCl_2$. These are just a few of the many cases of the distorting influences due to the formation of sub-compounds at the cathode.

At the anode Faraday found the electrolysis of fused $PbCl_2$ led to the formation of $PbCl_4$ which dissolved in the fused bath, but made no quantitative study of the problem. Lorenz and Auerbach[17] made the first quantitative investigation of anode reactions using fused $PbCl_2$. They found the yields of Pb and Cl_2 never were equal and that the main source of error was in the absorption of the gaseous Cl_2 by the electrolyte. By continued electrolysis the electrolyte soon became saturated with Cl_2 so that the yields rose rapidly until they almost equaled the yields of Pb. When carbon anodes were used much Cl_2 was absorbed into the pores of the electrode.

Distortion by Metallic Clouds

Metal clouds or fogs cause considerable diminution in the yields at the cathode. These clouds are composed of globules of metal or secondary products as ZnO, $Zn(OH)_2$, sub-oxide of Mg, etc., intimately dispersed through the catholyte. They are formed more at higher than at lower

[13] Bunsen, *Pogg. Ann.*, **91**, 619 (1854).
[14] Davy, *Phil. Trans.*, **98**, 1 (1808).
[15] Kirchoff and Bunsen, *Pogg. Ann.*, **113**, 364 (1861).
[16] Frary and Berman, *Trans. Am. Electrochem. Soc.*, **27**, 209 (1915).
[17] Lorenz and Auerbach, *Z. anorg. Chem.*, **28**, 1 (1901).

temperatures; at the boiling point of the metal the cloud is formed to the total suppression of metallic deposition on the cathode.[18]

The exact nature of these clouds is still a question: Bancroft[19] considers them to be colloidal solutions. Whatever they may be, it is known that the particles of the clouds are much smaller at higher than at lower temperatures and that they may, if the temperature rises sufficiently, form a true solution almost optically clear, returning to their heterogeneous form as the temperature drops. Because of these clouds which it is almost impossible to eliminate entirely, the best yields are obtained very near the melting point of the electrolyte. The amount of cloud formation seems to be a function of the vapor pressure of the metal being deposited and is not at all dependent on the passage of the current through the electrolyte, for clouds of sodium may be formed by putting solid sodium into fused NaCl.

Using a constant current, Faraday was able to show that the size of the electrode had a great influence on the amount of the metal deposited, though he could do nothing strictly quantitative with the question. Then Lorenz studied the relation of current density to current yields finding that both rose almost uniformly.[20]

As in aqueous solutions, so in fused electrolytes a fractional deposition of metals is possible from a mixture of the salts of several metals. Pb may be almost completely separated from Zn, Ag from Pb and Zn, Zn from Cu, Fe from Zn, especially when the chlorides of the metals are used.[21]

Decomposition Voltage

The following quotation gives the beginning of the work on the decomposition voltage of fused electrolytes:[22]

> It became requisite, for the comprehension of many of the conditions attending voltaic action, to determine positively, if possible, whether electrolytes could resist the action of an electric current when beneath a certain intensity? Whether the intensity at which the current ceased to act would be the same for all bodies? And also whether the electrolytes thus resisting decomposition would conduct the electric current as a metal does, after they ceased to conduct as electrolytes, or would act as perfect insulators.

The answer to this was that lead and silver chlorides were shown to be conductors when the intensity was below the value required to effect decomposition. The following is a list of compounds, the first of which are decomposed in the fused state by the current with the lowest intensity, as found by Faraday: chloride of silver, protochloride of tin, chloride of

[18] See Lorenz, *Z. Elektrochem.*, **7**, 277 (1901).

[19] "Applied Colloid Chemistry," first edition, McGraw-Hill Book Co., New York, 1921, p. 275.

[20] Lorenz and Appelberg, *Z. anorg. Chem.*, **36**, 36 (1903).

[21] Lorenz, *Z. anorg. Chem.*, **10**, 78 (1895); *Z. Elektrochem.*, **2**, 318 (1895).

[22] Faraday, *op. cit.*, p. 292.

lead, iodide of lead. In other words the quantitative measurement of decomposition voltage had not been possible during his day; the influence of electrodes and foreign bodies in the electrolyte was, however, recognized.

After Faraday, the next study of decomposition voltages was by Lorenz,[23] with the first really accurate work by the same investigator being on the decomposition of fused zinc chloride,[24] after which many determinations were reported with a variety of methods.

There are many distorting influences in the determination of the voltage of decomposition; the results as they stand at present need some clarification and the repetition of some of the work will be the only method of solution. Polarization and depolarization with the side reaction at the electrodes cause an almost endless amount of trouble in getting at the true decomposition value. For some salts peculiarly there seem to be two decomposition voltages.

Organic Compounds

The next item of interest is the electrolysis of the fused salts of organic acids. It seems that only this group of organic compounds has been studied, and that not at all completely. Faraday[25] in 1833 stated that:

"Acetate of soda fused and anhydrous is directly decomposed, being, as I believe, a true electrolyte, and evolving soda and acetic acid at the cathode and anode. These, however, have no sensible duration, but are immediately resolved into other substances; charcoal, sodiuretted hydrogen, etc., being set free at the former, and, as far as I could judge under the circumstances, acetic acid mingled with carbonic oxide, carbonic acid, etc., at the latter." Lassar-Cohn subsequently obtained CH_4 and H_2 at the cathode with CO_2 as the anode gas.[26]

In 1904 Berl repeated the work of Faraday and of Lassar-Cohn, using pure fused potassium acetate and also a fused mixture of sodium and potassium acetates.[27] The previous work was verified in that the anode gases consisted of 44% H_2, 26% CH_4, and 21% CO_2. The mechanism suggested by Berl is that the decomposition of the electrolyte is due to the action of metallic sodium, liberated at the cathode, on the fused salt. This mechanism was verified by experimental evidence. Petersen,[28] with a fused eutectic mixture of lead and zinc acetates, obtained very little ethane but did get large yields of H_2 and CH_4. Larger yields of ethane were obtained from a fused mixture of lead and sodium acetates. Fused lead salts of propionic and butyric acids yielded very much smaller amounts

[23] Lorenz, *Z. anorg. Chem.*, **10**, 272 (1895); *Z. Elektrochem.*, **2**, 318 (1895).
[24] Lorenz, *Z. anorg. Chem.*, **12**, 272 (1896).
[25] Faraday, "Experimental Researches," vol. 1, p. 228.
[26] Lassar-Cohn, *Ann.*, **251**, 357 (1889).
[27] Berl, *Ber.*, **37**, 325 (1904).
[28] J. Petersen, *Z. Elektrochem.*, **20**, 328 (1914).

of the paraffin compounds than could be expected if the reactions were perfectly analogous to the results of the electrolysis of their respective aqueous solutions.[29]

Theory of Ionization

For obvious reasons there has not been as much work reported on the conductivity and related phenomena, *i. e.*, ionic mobility, etc., of fused electrolytes, as in the study of solutions. That which has been reported is not at all at variance with the fundamental postulates of the theory of Arrhenius as the explanation of electrical conductivity. Faraday first sensed the problem and studied it qualitatively; in 1887 Hampes reported more qualitative data. The first quantitative work was reported by Matteucci in 1845 and since then various investigators have sustained the assumption that fused electrolytes conduct just in the same manner as do solutions of electrolytes. Transport numbers, etc., can be determined—of course with great difficulty, it is true—just as in the case of solutions.

The discussion by Lorenz[30] brings the theory of conductivity of fused electrolytes into harmony with the theory of ions. Since this time excellent work on the conductivity has been reported by Goodwin[31] and Jaeger and Kampa.[32] Much, however, remains to be done in order that mathematical formulas may be built up so that the theory is as firmly grounded as it is for dilute solutions. So far the range of work is rather limited.

Fused Electrolytes in Metallurgy

To go in detail into the vast subject of the rise of fused electrolytes in metallurgy would be too far afield for a study of this nature. Indeed, it would be very difficult to name the most important processes in metallurgy. So many metals have been made available from these electrolytes that only mere mention of some of the most important can be made at this point.

The very strongly electropositive metals which have the greatest affinity for oxygen are not very easily prepared by chemical methods. In general the liberation of the metal from its very stable compounds, such as the oxides or halides, requires the application of a still more electro-positive metal or some other powerful reducing agent, the process usually being carried out at elevated temperatures. Chemically, therefore, these processes are expensive. In most instances the now fairly cheap metals were mere scientific curiosities until the advent of electrochemical methods and fused electrolytes.

[29] This difference in action is discussed in a book by the author entitled "Electro-Organic Chemistry," John Wiley & Sons, N. Y., 1926.

[30] Lorenz, "Die Elektrolyse geschmolzener Salze," vol. 3, p. 289 ff.

[31] H. M. Goodwin and R. D. Mailey, *Phys. Rev.*, **26**, 28 (1908).

[32] *Z. anorg. allgem. Chem.*, **113**, 27 (1920).

Sodium decomposes water and therefore it cannot be readily deposited from aqueous solutions of its salts. The fused anhydrous salt is then resorted to and the electric current deposits the metal on the cathode.

There are, as stated above, distorting influences that figure in the successful prosecution of the methods. In most cases these deleterious effects have been almost completely removed so that today electrolytic sodium and aluminum have entirely displaced those produced by the older chemical methods. Magnesium and calcium have always been prepared industrially by the electrolytic method. Cerium, for use in pyrophoric alloys, and some zinc are prepared from fused electrolytes.

Very little progress was made, in fact very little investigation was carried on, before the invention of the modern dynamo-electrical machinery. This gave the proper source of cheap electricity and the electrochemical processes at once developed.

Sodium had been prepared by Davy (*loc. cit.*) and studied by several others but the industrial application came with the Castner patents[33] in 1890. Aluminum was not isolated by Davy in his work on the earth in 1808 but it was found by Bunsen in 1854 and prepared on a semi-commercial scale in the same year by St. Clair Deville. The process they used consisted of the electrolysis of the fused chloride. The method of today is based on the Hall patents of 1883 which were practically contemporary with the patents of Heroult. Briefly, the system is to electrolyze a solution of Al_2O_3 in fused cryolite, depositing the aluminum on a cathode of the solid electrolyte or of carbon at a temperature sufficiently high to keep both the metal and the bath well molten. The most noteworthy developments have been made since 1900.

Metallic calcium is used in hardening lead alloys and in making bearing metals of various sorts. It was prepared first on a large scale by Bunsen in 1855, though the yields were very low. He used calcium chloride as the electrolyte but at the high temperature necessary to keep the chloride bath molten (780°) and the low melting point of calcium (800°), the temperature limits were too narrow for a successful operation. The calcium was deposited in a finely divided condition and readily ignited at the temperature of the bath, making the melt basic in reaction. The method used today is the contact electrode principle[34] which minimizes the trouble due to fogs, and further reactions of an undesirable nature.

Frary metal, the bearing metals "Ulco" of the United States, and "Lurgilagermetall" of Germany are the important uses for metallic calcium.

Since the time of Davy the use of fused electrolytes has been applied either for the discovery or the commercial preparation of many metals,

[33] U. S. P. 452,030; Brit. P. 13,356.

[34] Rathenau, *Z. Elektrochem.*, **10**, 508 (1904).

among which probably the most important are sodium, potassium, lithium, calcium, strontium, barium, cesium, rubidium, magnesium, aluminum, beryllium, cerium, radium, tantalum, thallium, titanium, uranium, and vanadium.

New-Found Bacteria Deadly to Insects. Several new diseases of insects, due to bacteria that have hitherto not been observed by scientists, have been reported to the American Museum of Natural History by F. Martin Brown, of St. George's School at Newport.

Three species of bacteria and one mold were isolated from a number of dead wood-flies found on an asparagus stalk. Experiments showed that one, which has been named "Bacillus lutzae," in compliment to Dr. F. E. Lutz, entomologist of the museum, is fatal to houseflies.

Another germ proved lethal to an insect that gives people pleasure instead of doing them harm. It kills the common bright Monarch butterfly over night. Mr. Brown conjectures that this disease may be the cause of the decline in numbers of this butterfly in the East during recent years.

The researches were carried on at the community hospital at Tuxedo, N. Y., with the coöperation of Dr. Edward C. Rushmore and Miss Margaret Stevens.—*Science Service*

Mosquito-Killing Oil Helped by Tar Acids. "More dead skeeters per gallon" is the aim of Dr. Joseph N. Ginsburg of the New Jersey Agricultural Experiment Station, who reported on his researches with fuel oil as a mosquito-killer before the meeting of the New Jersey Mosquito Extermination Association. Oil spread on water to kill mosquito "wigglers" is a standard remedy for the stinging pests and one widely employed, but when vast areas of swampy land have to be treated, as they do along the Atlantic Coast, the spread per gallon becomes an important thing, Dr. Ginsburg reminded his hearers. In his laboratory experiments he found that the addition of certain organic acids derived from tar would make a gallon of oil blanket half again as much water as could be covered by a like quantity of untreated oil, and that the acidified oil made conditions intolerable for mosquitoes for an appreciably longer time.—*Science Service*

New Instrument Measures Tiny Electric Current. An electric current, so small that at the pressure and price of the ordinary house lighting current it would cost less than a four-hundred-billionth of a cent, can be measured with the aid of a new instrument just developed in the standardizing laboratory of the General Electric Company at Lynn, Massachusetts. It is known as a thermionic microammeter, and a current of a ten-millionth of an ampere is sufficient to carry the pointer completely across the dial, while a single division on the scale represents one five-hundredth of this amount.

The instrument will be useful in measuring the minute currents in insulators and radio tubes, but it is stated that the chief application foreseen at present will be in combination with a photo-electric cell for accurate measurements of illumination. At present the intensity of electric lights, for example, is measured by visually comparing them with another light of standard brightness. The electrical eye, the photo-electric cell, may now replace the human eye in this work, for the cell converts light energy into tiny electrical currents, which may be easily measured with the new instrument.—*Science Service*

REGULATIONS FOR THE FORMATION OF STUDENT CHAPTERS OF THE NORTHEASTERN SECTION, A. C. S.

The Northeastern Section of the American Chemical Society, having established an Associate Membership, found that a certain class of chemical students in the universities was not being brought into the organization as was desirable. The officers consequently appointed a committee for the purpose of formulating plans through which students in universities or technical schools in the Northeastern area could become affiliated with the Section. This committee, after long study, drew up the following proposed regulations for student chapters of the Northeastern Section of the A. C. S.

Report of the Committee

Any society of undergraduates in a university or technical school of recognized standing, comprising students pursuing a regular course of study in chemistry, chemical engineering or closely allied subjects, may be recognized by the Northeastern Section of the American Chemical Society as an Affiliated Student Chapter under the following conditions:

1. Student Chapters may be organized or affiliated or both on recommendation of the Committee on Associate Membership, with the subsequent approval of the Executive Committee, with a limited use of the privileges of the Northeastern Section.

2. Members of such Chapters shall not be considered in any way to be members of the American Chemical Society, and no irrevocable privilege shall be conferred by affiliation.

3. Annual dues of Student Chapters shall be $— per year per member, payable in advance on Nov. 1st, and in full payment to July 1st, of the following year. One dollar shall be applied by the Northeastern Section to subscription to the *Nucleus* or other publications of the Northeastern Section, such publication to be mailed directly to the member.

4. The qualifications required of a Student Chapter shall include: (*a*) An organization with a minimum membership of eight full-time students in a university or engineering school of recognized standing, where at least three members of the instructing staff are members of the American Chemical Society. (*b*) The endorsement of the application by the head of the department of chemistry.

The designation "full-time student" includes those who devote a major part of their time to study.

The expression "school of recognized standing" applies to schools of college grade giving a chemical or chemical engineering course of not less than three years, and one which grants degrees.

5. Each Student Chapter shall have its own name and individuality, shall establish its own rules and regulations for government and procedure, shall control the occurrence and character of its own meetings, except joint meetings with the Northeastern Section of the American Chemical Society and other affiliated Student Chapters, of which there shall be four throughout the school year, shall solicit its own membership and shall elect a representative, preferably its Chairman, to meet, without a vote, with the Executive Committee of the Northeastern Section Joint Meetings, this representative to represent the Student Chapter in joint action of the two organizations.

6. The duties of the representative of the Student Chapter shall include: (1) To

supply a complete list of the members and their addresses to the Secretary of the Northeastern Section and to the Manager of the *Nucleus;* (2) to be responsible to the Treasurer for dues; (3) to give on call to the Editor of the *Nucleus* a statement of meetings held and to be held by the Student Chapter, date and attendance, principal speaker and subject, and also notice of other activities for publication; (4) to supply in June of each year the names of the officers for the next year, and to keep the Secretary of the Northeastern Section informed of changes; (5) to assist in the arrangement of the four joint meetings; (6) to canvass the graduating members of the Student Chapter and to present advantages of membership as allowed under the Constitution and By-Laws of the American Chemical Society and the Northeastern Section; (7) the conditions and details of relation between the Northeastern Section and the Student Chapters may be changed at any time by the Executive Committee of the Northeastern Section (student members voting) and the relation itself may be terminated at any time by the action of either party.

Among the privileges and advantages to the Student Chapters are:

1. The right to attend, as guests, all the meetings of the Northeastern Section, to participate in the social activities and to accompany all the inspection trips arranged by the Northeastern Section.
2. The privilege of hearing speakers whose personal experiences qualify them to speak with authority upon subjects of importance to chemists.
3. The opportunity to meet jointly with chemists in industry and members of other student chapters as shall choose to affiliate.
4. The opportunity to reduce organization expenses by joint meetings, including the opportunity for all concerned to engage speakers of bigger reputation because of a large audience guarantee.
5. The opportunity and obligation to publish notices of its activities and the names and addresses of its officers in the *Nucleus*, which will be mailed to each member each month, and likewise to be informed of the activities of other Affiliated Chapters of the Northeastern Section.
6. The privilege of any member to publish requests for summer employment during the college course, or for permanent engagement after graduation at reduced rates in the *Nucleus*, which is circulated to over 800 chemist members of the Northeastern Section of the American Chemical Society.
7. The opportunity for men in smaller colleges where student societies do not exist or where student societies can be of little importance to attend the meetings of a larger organization and to associate with students from other colleges and also with chemists actively engaged in industrial work.
8. The Northeastern Section, through its Secretary, will arrange on application as far as possible conferences between any of its 800 members actively engaged in industrial work and students interested in certain lines, especially in regard to thesis work, whereby information, facilities, and assistance may be supplied with advantage to both parties.
9. Technical papers which are the original work of a member of the Student Chapter and which may have been presented before that Chapter and recommended by its officers and submitted to the Executive Committee, Northeastern Section, will be received, referred to an expert and conferences arranged whereby the paper may be criticized and if of suitable quality arrangement will be made for publication in the national or local publication with the names of authors and due acknowledgment to the affiliated Student Chapters.
10. Members of affiliated Student Chapters may on application be proposed for

membership in the American Chemical Society or may be granted the privilege of being Associate Members of the Northeastern Section from the time of graduation until one year from the following Jan. 1st.

11. The opportunity and obligation to assist in a recognized way through a recognized body in the advancement of the chemical profession and the industry in public estimation.

12. The assurance of the coöperation of the Northeastern Section to the extent of the appointment of Student Chapter Advisers if necessary in advancing the interests of Student Chapters.

Among the privileges and advantages to the Northeastern Section are:

1. Association of its members with younger men whose business in life will be chemistry, therefore eventually wider acquaintanceship.

2. Better contact between industry and the college student.

3. Opportunity to assist the smaller colleges to maintain student interest in the development of chemistry.

4. Opportunity to acquaint the budding chemist with the A. C. S., its membership, ideals, publications, advantages, etc., etc.

L. F. HAMILTON, *Chairman*

Acting upon the foregoing report, the Executive Committee issued an application blank, with the result that the Northeastern Section now has six Student Chapters, comprising about four hundred members. The Section is interesting these members in the activities of the Society as rapidly as possible. The plan appears a good one, and as far as it has been possible to judge in the short time it has been effective, the results are promising.

Uncle Sam to Study Wastes in Cotton, Corn, and Peanuts. How to put corn stalks, peanut shells, and cotton stalks to use are the problems that engineers of the U. S. Bureau of Standards are about to tackle. Congress has appropriated $50,000, available July 1st, for an investigation looking toward the utilization of waste products from the growing of corn, peanuts, and cotton.

Scientists recall that at one time the seeds of cotton were considered valueless and that now they form the raw material for a vast industry. The grains of corn which, except for the relatively small part of the leaves and stalk used for fodder, constitute the only usable part of America's great corn crop, and since the grain represents only about a fifth of the total weight of the corn plant, experts see the possibility of using the stalks and cobs. Various methods of harvesting, collecting, and bringing together enough stalks to make utilization possible are being considered. Manufacture of paper, alcohol, and other chemical products from the stalks is being considered. A similar problem is presented by the peanut hulls which now constitute a waste by-product of large magnitude.

Warren E. Emley, Bureau of Standards engineer, is now making a survey of the problems and expects to receive suggestions and descriptions of various possible utilizations from those who have ideas upon the problem. He will shortly make a trip into the corn belt states where some experimental work has already been started.—*Science Service*

THE REDUCTION OF STANNIC CHLORIDE BY METALS*

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One of the most frequent errors in qualitative analysis is the omission of tin.[1] With beginning students, the detection of this element may be said to be almost fortuitous. Many teachers have a suspicion that the error is due to a failure to reduce stannic chloride to the stannous stage—a step involved in practically every scheme of analysis of the tin group. This paper is a synopsis of a study of this reduction, undertaken with a view to formulating a laboratory procedure that will be as dependable as possible.

A number of metals have been used for the reduction of stannic solutions to the stannous stage, including zinc, iron, lead, cadmium, aluminum, magnesium, manganese, cobalt, and nickel. Among recent investigators of the problem, the work of Jelek[2] is the most noteworthy. However, he was concerned with the completeness of the reduction of the stannic compound rather than the efficiency of the metals as specific reducing agents. The purpose of the work now to be reported is different; it has been to answer the question, what metal is the most suitable reducing agent for stannic chloride in qualitative analysis from the standpoint of quantity and time? The metals used in this work were aluminum, zinc, iron, and lead. They were all of high purity. The aluminum and iron were in the form of wire, the zinc was the mossy form, and the lead was the sheet form.

Mechanism of the Reaction.—Oxidation-reduction potentials as represented in the e. m. f. series, indicate that when a reactive metal is added to an acid solution of stannic chloride, the reaction should proceed in stages. Illustrating with zinc as the reducing agent, the ionic equations for these stages in the order of their chemical potential would be:

$$(1)\quad Sn^{++++} + Zn \longrightarrow Sn^{++} + Zn^{++};$$
$$(2)\quad 2H^{+} + Zn \longrightarrow H_2 + Zn^{++};$$
$$(3)\quad Sn^{++} + Zn \longrightarrow Sn + Zn^{++};$$
$$(4)\quad 2H^{+} + Sn \longrightarrow Sn^{++} + H_2.$$

Proceeding on the assumption that equation (2) is the only one that laps with equation (1), the volume of hydrogen evolved might be taken as an indirect measure of the efficiency of the reduction. That is, for 100

* The experimental part of this work was done by Mr. Appling in 1924–25, when he was instructor in the University High School at Urbana, Illinois, utilizing vacant periods and working out of hours. This work is reported, not only for its intrinsic value, but as evidence that the field of research is not closed to high-school instructors. —J. H. R.

[1] *Cf.* Heisig, THIS JOURNAL, **3**, 179 (Feb., 1926).

[2] *Chem. Listy*, **17**, 223–7, 268–73, 295–302 (1924).

per cent efficiency the volume of hydrogen should be zero. Victor Meyer's apparatus for determining vapor densities was used in this work. However, the results were very erratic and inconsistent in amount. Catalytic effects of impurities in the metals may affect the reaction to some extent, but careful observation showed that in the experiments with aluminum and zinc, metallic tin was deposited, indicating that equations (3) and (4) were also operative. The tin separated in this way upon redissolving liberated a volume of hydrogen which does not represent any inefficiency on the part of the reducing metal. The evident explanation of this behavior is that all the reactions take place at the surface of the metal, the relative speeds depending upon the concentrations of the Sn^{++++}, H^+, and Sn^{++} ions in the surface layer. The Sn^{++++} ions, on account of their low mobility, diffuse up to the surface of the metal only slowly, making it possible for the latter to react with the H^+ and Sn^{++} ions.

Efficiency of reduction is, therefore, to be measured by determining the amount of stannous chloride produced. At first this was done by adding the reduced solution to an excess of mercuric chloride and determining gravimetrically the mercurous chloride precipitate. Later, on account of the difficulty in filtering and washing this precipitate due to its colloidal nature, the stannous content of the solution was determined by titration with standard potassium permanganate. In the cases where iron was the reducing metal, allowance was made for the ferrous chloride introduced into the solution.

Effect of Acidity.—The general effect of increasing the acidity of the stannic chloride solution is to reduce the efficiency of the reduction. Efficiency is used in this paper to mean the ratio between the amount of stannous chloride produced and that called for by equation (1). Volumes of 50 cc. of 0.2*M* $SnCl_4$ containing concentrations of hydrochloric acid ranging from 1- to 5-molar were treated with equivalent amounts (about 3 milli-equivalents) of aluminum, zinc, and iron. The efficiencies obtained are shown graphically in Fig. 1. It should be stated that concordant results could not be obtained with zinc and iron, and the graphs show the results of a series of experiments that may be taken as representative. As Jelek remarked with respect to zinc, the results are "irregular, very irregular." Aluminum, on the other hand, gave results that were fairly consistent, and always reproducible within two or three per cent.

Effect of Temperature.—The efficiency of the reduction is considerably reduced by elevating the temperature, indicating that increase in temperature favors equation (2) considerably more than equation (1). The probable explanation is that the mobility of the H^+ ion increases with temperature more rapidly than that of the Sn^{++++} ion. On the other hand, the whole reaction proceeds much more rapidly at higher tem-

peratures, so that the loss in efficiency is more than compensated for in the increase in speed.

Extent of Surface.—Sometimes the metals are introduced as a powder instead of in the massive form, for the purpose of reducing the time element. Experiments uniformly showed that this practice results in a lowered

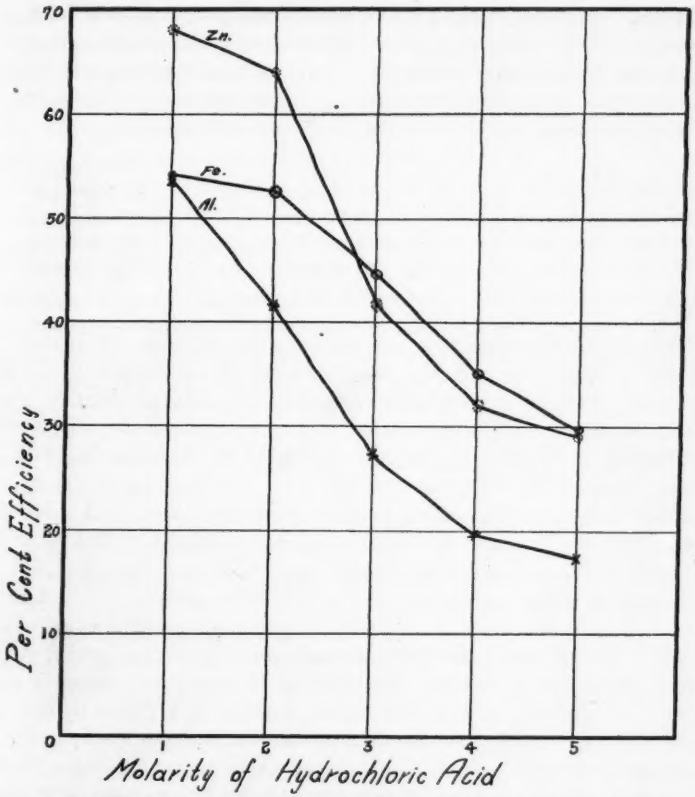

FIG. 1.—Effect of Acidity upon the Efficiency of Reduction of Stannic Chloride Solution.

efficiency. The particles of metal are floated to the top of the solution by bubbles of hydrogen, so that the larger portion of the mixture is only slightly affected. When the metal remains at the bottom of the container, the hydrogen evolved seems to stir the solution, and increased reduction is obtained.

Amalgamation with Zinc.—It is well known that coating the surface

of zinc with mercury retards its displacement of H^+ ions from solution. This suggests that amalgamation should repress equation (2). Experiments showed that while the evolution of hydrogen was diminished, the reduction of the stannic chloride was slowed down to almost exactly the same extent. That is, there is a loss in speed without a corresponding gain in efficiency.

Speed.—Equivalent amounts of aluminum, zinc, iron, and lead were placed in flasks containing 50 cc. volumes of 0.2*M* stannic chloride in 4 per cent hydrochloric acid solution, and all were simultaneously heated on the same steam-bath (about 75°C.). The following table shows the time required for solution and the efficiencies obtained:

Metal	Time	Efficiency
Al (90 mg.)	9 minutes	55.0 per cent
Zn (326.9 mg.)	32 minutes	87.3 per cent
Fe (279.2 mg.)	60 minutes	86.8 per cent
Pb (1036 mg.)	600 minutes (estimated)	77.1 per cent

The efficiencies of these metals appear quite different when time and weight are taken into account. Per gram per minute, aluminum has been calculated to be 80 times as effective as zinc, 130 times as effective as iron, and 7000 times as effective as lead.

Possible Reduction of Mercuric Chloride by Ferrous Chloride and Other Substances.—The use of iron as a reducing agent for stannic chloride is open to the objection that concentrated ferrous chloride solution sometimes gives with mercuric chloride a turbidity that looks like the precipitate obtained with a small amount of stannous chloride. The composition of this precipitate is not definitely known. At first it was assumed to be the double salt, $FeCl_2.HgCl_2.4H_2O$, isolated by von Bonsdorff[4] a century ago. However, a small quantity of this precipitate was prepared by mixing concentrated solutions of ferrous and mercuric chlorides. The precipitate was thoroughly washed with dilute hydrochloric acid and, upon adding ammonium hydroxide, turned black, indicating mercurous chloride. From this it appears that very high concentrations of ferrous chloride may reduce mercuric chloride to an appreciable extent.

Mr. John Wierda, while at the University of Illinois, called attention to the following interesting behavior: If aluminum is dissolved in cold hydrochloric acid, and the solution filtered at once into mercuric chloride solution, a slight precipitation of mercurous chloride occurs, although Sn^{++} and similar reducing ions are absent. This effect is prevented by boiling the solution for a minute or two before adding it to the mercuric chloride solution. This peculiar phenomenon has not been explained. It may

[4] *Pogg. Ann.*, **17**, 133 (1829).

be attributed to nascent hydrogen present in the solution, or possibly to soluble hydrides of impurities present in the aluminum.

Procedure for Reducing Stannic Chloride.—The following procedure for reducing stannic chloride is suggested, based on the foregoing results: The solution is concentrated to a small volume (say, 10 cc.) and half its volume of dilute HCl (6*M*) added, giving the acid a concentration of about 2-molar. A piece of aluminum wire (about 10 mg. is sufficient) is added and the solution is heated just below its boiling point for three or four minutes. If a mouse-colored coating (metallic tin) forms on the aluminum, it is dissolved by adding concentrated HCl (12*M*) and boiling gently. Filter into mercuric chloride solution. A white precipitate of Hg_2Cl_2 indicates the presence of Sn^{++++}.

The mercuric chloride test for stannous chloride is exceedingly sensitive. A trial showed that 0.00001 gram of tin in a volume of 10 cc. could be detected in this way. Consequently, even with a low efficiency in reduction, the test should be positive if stannic chloride is present in appreciable quantities. This points to the conclusion that the omission of tin by beginners is probably due to its loss in some operation prior to the reduction of the stannic chloride.

Summary

1. The reduction of stannic chloride solution by a metal under ordinary conditions of stirring is not a simple reaction, but consists of four concurrent reactions.

2. Acidity reduces the efficiency of the reduction.

3. The efficiency of the reduction becomes less with increasing temperatures, but the gain in speed compensates for the loss.

4. Better reduction is obtained by using the metal in the massive, rather than the powdered form.

5. Amalgamation reduces the speed of reduction.

6. Aluminum is the best metal for the reduction on account of the high speed of its action.

7. Concentrated ferrous chloride solution may give a pseudo test for Sn^{++} with mercuric chloride solution.

8. These results have been embodied in a procedure for testing for tin in stannic chloride solutions.

Automobile Finish Used to Preserve Specimens. A small but important new use for the new cellulose lacquers, to preserve from evaporation the delicate specimens mounted on microscope slides, is described by Prof. A. V. Mitchener of Manitoba Agricultural College. He seals the edges of the cover glass to the slide with a ring of lacquer, which quickly dries and makes a permanent mount. Shellac and other substances hitherto used for this purpose have not been very satisfactory.—*Science Service*

THE SOLUBILITY OF CHROMIC HYDROXIDE IN ALKALIES

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In almost every textbook on general chemistry or qualitative analysis that has come to the attention of the writer the solubility of chromic hydroxide in solutions of caustic alkalies has been ascribed to the formation of a chromite for which the formula $NaCrO_2$ is generally written. This explanation may possess certain pedagogic advantages in serving to emphasize the analogy between aluminum and chromium in many compounds. However, a review of the literature fails to reveal much reason for belief in the formation of chromites except by fusion methods. No comprehensive survey of the evidence will be attempted, but the results of some of the published experiments in this connection should prove interesting.

Herz[1] noticed that when alkali was added to a solution of a chromic salt a precipitate formed which was readily soluble in the precipitant. However, if the precipitate were filtered off, washed and dried, it became practically insoluble in the same reagent.

Later Herz and Fischer[2] undertook a study of the nature of the solution of chromic hydroxide in alkali. They found that such solutions became turbid on standing, finally yielding a precipitate which settled out. Precipitation was retarded by excess of alkali, but greatly accelerated by heating. From these observations they were led to the conclusion that the chromium was present in the alkali solution in the form of a colloidal suspension of chromic hydroxide, not in the form of a chromite.

To test further their conclusions they treated a chromic chloride solution with an excess of alkali, and subjected the solution thus obtained to dialysis. Alkali passed through the membrane, but chromium did not. Additional confirmation was obtained from experiments upon the electrical conductivity of the mixture. To a solution of chromic chloride an excess of alkali was added and the electrical conductivity was measured. The solution was then heated so as to precipitate the chromium. A redetermination of the conductivity after the removal of the precipitate by filtration gave the same value as before. The authors concluded that all of these experiments were best explained by ascribing a colloidal nature to the solution of chromic hydroxide in alkali. They pointed out that in this respect chromium differs from aluminum which forms a compound under the same conditions. These conclusions were questioned by Kremann,[3] but the experiments of later investigators have served to confirm them.

[1] Herz, *Z. anorg. Chem.*, **28**, 344 (1901).

[2] Herz and Fischer, *Ibid.*, **31**, 352 (1902).

[3] Kremann, *Ibid.*, **33**, 87 (1902); **35**, 48 (1903).

Nagel[4] has shown that from a solution of chromic oxide in alkali the chromium may be precipitated readily by colloidal ferric oxide. In another experiment he found that by the use of a collodion ultra-filter it is possible to filter out hydrous chromic oxide from its solution in caustic alkali.

Weiser[5] published a comprehensive review of the literature in his study of hydrous chromic oxide. He concludes that "hydrous chromic oxide is peptized by alkali and that no appreciable amount of chromite is formed within a reasonable time."[6] A concise review of the chemistry of hydrous chromic oxide is given in a more recent article by Seymour-Jones.[7]

Several authors describe the settling of chromic hydroxide from its solution in alkali, but in no case is mention made of testing the supernatant liquid for chromium. It occurred to the writer that a small amount of chromite might be detected in this solution if a delicate test for chromium were applied.

With this in mind, a series of twelve solutions was prepared by treating chromic chloride with an excess of sodium hydroxide. The resulting solutions were all 0.1 normal with respect to $CrCl_3$. The NaOH content ranged from 0.1 to 1.4 normal. They were placed in tightly stoppered test tubes and allowed to stand.

One by one, the solutions became turbid and deposited a green precipitate, leaving a clear colorless liquid above. Turbidity and precipitation appeared first in those solutions which were lowest in alkali content. At the end of about eight weeks, settling was sufficiently complete so that samples of the supernatant liquid could be removed with a pipette. They were tested for chromium by first oxidizing with hydrogen peroxide in alkaline solution and then applying the perchromic acid test. In every case the result of the test was negative. Comparison tests on solutions of known chromium content showed that 0.01 mg. of chromium could be detected readily under similar conditions.

The writer does not attach any great significance to the results of these experiments. Nevertheless, they are interesting in as much as they appear to be in line with the evidence already cited, the great bulk of which seems to establish the fact that the solubility of chromic hydroxide precipitates in excess of alkali is due primarily to the formation of a colloidal solution, and to leave us little reason for the belief in the formation of a chromite.

[4] Nagel, *J. Phys. Chem.*, **19**, 331, 569 (1915).
[5] Weiser, *Ibid.*, **26**, 401 (1922).
[6] *Ibid.*, **26**, 429 (1922).
[7] Seymour-Jones, *Ind. Eng. Chem.*, **15**, 75 (1923).

Chemical Digest

ABSTRACTS

Are the Test Tube and Microscope Final? ANON. *Gen. Sci. Quart.*, **11**, 95 (Jan., 1927).—*Zion Herald* gives an abstract of the address of Dr. Allan Craig, of Chicago, at a recent meeting of the American College Surgeons in Montreal, Can. The value of a 150-lb. man, based on current prices of the chemical constituents is 98 cents. Life Insurance companies place the economic value of the man at $5000. How account for the difference of $4999.02? The answer is in the value of the spirit within the man. "The churches of today must come out of the clouds. The people of today are not irreligious. But our young people are not interested in fundamentalism or the higher criticism. They care little about Lot's pillar-of-salt wife, or Jonah's escape from the interior of the whale. The young people are interested in clean living and moral precepts as laid down in the Ten Commandments. Medical science is just as much interested in the observation of the Ten Commandments as are the churches."

J. H. G.

Laying the World's Fastest Ocean Cable. *Gen. Sci. Quart.*, **11**, 118–24 (Jan., 1927); extracts from *Western Electric News*.—Chas. W. Barrell tells of filming the landing of the permalloy cable from Bay Roberts, Newfoundland, to Penzance, England. The ship "Cyrus Field" laid this cable. An account of the laying of the first cable by the "Great Eastern" and the sending of the cable ashore at Heart's Content, on July 27, 1866, is touched upon.

J. H. G.

Enriched Courses for Bright Pupils. R. A. VANCE. *School*, **38**, 374 (Jan. 27, 1927).—In an address before the New York Society for the Experimental Study of Education at its January meeting, R. A. Vance, principal of the St. Clair McKelway junior high school, advocated scientific study to ascertain whether the "rapid-advancement classes" in junior high schools, in which pupils of superior mentality complete the work of three years in two years, are not imposing too great a burden on the pupils.

Mr. Vance's objections to rapid advancement classes are (1) too great a strain upon children at a critical period in their psychological development, (2) the failure of these pupils to measure up to the requirements of more mature pupils in the upper grades of senior high school.

His suggestion is a full three years' course for all students but an enriched curriculum for the bright students.

Mr. Vance also discussed (1) promotion by subjects, (2) the junior high school as an educational unit with unbroken progress through the three years, and (3) how to modify the curriculum.

E. L. M.

Natural Sciences. EDITORIAL. *High-School Teacher*, **3**, 16 (Jan., 1927).—"In analyzing the values of science for the instruction of youth in our high schools the most common fallacy is the failure to distinguish between the importance of the knowledge of this subject on the part of a few specialists and the much slighter importance of such knowledge on the part of all." The writer does not question the value of science but suggests that the science study required of every student be more directly serviceable to him than a subject such as physics. General science is most usually presented so that it more readily justifies itself for the rank and file of individuals. The writer criticizes the science courses usually offered because they are too largely organized into separate divisions in which material is arranged in logical sequence as determined by specialists in that particular field; too much presentation of essentials with their definition and classification, instead of presenting the manifestations of science in the home, community, civic, and industrial situations which make it possible for the learner to practice science.

In the teaching of science he suggests that a start be made with questions of immediate interest to the pupil, ideas which are significant to him by reason of his own experience and which concern his own life to such an extent that he perceives or is easily led to perceive their worthwhileness.

E. L. M.

Mercury and Ammonia Vapor an Explosion Hazard. CHARLES VAN BRENT. *Science*, **65**, 63–4 (Jan., 1927).—Account of an explosion in an iron U-tube safety valve containing mercury and used to keep aqueous ammonia under a working pressure of

about four inches of mercury. The apparatus had been used ten years before the explosion occurred. G. H. W.

Allotropy. A. SMITS. *Nature*, **118**, 916–20 (Dec. 25, 1926).—A concise article on allotropy with special reference to the work of Baker on intensive desiccation. H. K. M.

Laue Photographs Taken with a Long Slit. U. YOSHIDA AND K. TANAKA. *Nature*, **118**, 912–3 (Dec. 25, 1926).—A study of single crystals made by the method of Carpenter and Elam (*Proc. Roy. Soc.* (London), **1921**). A photograph is included—the Laue spots become an assemblage of many lines. The method is simple and shows clearly whether the specimen is composed of a perfect single crystal or not. H. K. M.

Active Nitrogen. R. C. JOHNSON. *Nature*, **119**, 9–10 (Jan. 1, 1927).—A further discussion as to whether active nitrogen is atomic nitrogen. Johnson favors the evidence of Birge and Sponer. H. K. M.

Chinese Alchemy. J. R. PARTINGTON. *Nature*, **119**, 11 (Jan. 1, 1927).—It is generally agreed that chemistry had its origin about the first century A.D. at Alexandria, where the Egyptian metallurgical and technical arts combined with speculative philosophy and theosophy to form a belief in the possibility of the transmutation of metals into gold. On the conquest of Egypt by the Arabs in A.D. 640, this knowledge passed to Arabia, largely through the intermediary of Syriac translations of Greek treatises. Arabic chemistry is not earlier than the seventh or eighth century A.D. and appears to be greatly dependent upon that borrowed from Alexandria. Berthelot considers that Chinese alchemy was derived from the Arabs. This late origin is very definitely in contradiction to the Chinese accounts. The Chinese accounts have been interpolated but any conclusions which may be drawn as to the dates of Chinese texts which are based on the belief that accounts in them of alchemy must have come from Greek or Arabic sources are highly doubtful, but the matter is still quite open and it is hoped that the attention of competent Chinese scholars may be attracted to an interesting and valuable period in the history of chemistry. H. K. M.

X-Ray Evidence for the Existence of Different Modifications of Fatty Acids. G. M. DE BOER. *Nature*, **119**, 50 (Jan. 8, 1927).—Additional evidence to show that the different spacings of stearic acid seem to be independent of the temperature and only to depend on the manner in which the reflecting layer is obtained. The transition probably takes place between 12.5°C. and 17°C. H. K. M.

Lengthened Chain Compounds of Sulfur. P. C. RAY. *Nature*, **119**, 124 (Jan. 22, 1927).—The author reassures us concerning the purity of his sulfur compounds, particularly $Br.C_2H_4(S{-}C_2H_4)_{48}Br$ and points out that such compounds are few. H. K. M.

The Scattering of Gamma Rays. L. H. CLARK. *Nature*, **119**, 121 (Jan. 22, 1927).—The scattered radiations are considerably softer than the gamma rays producing them and experiments were made to determine the effect upon ionization measurements of lining the electroscope with cardboard 0.18 cm. thick. When ionization was due to radiation of the same wave-length as the primary gamma-rays the insertion of the lining increased the apparent transmission of a filter—the value for a lead filter 10.1 cm. thick being 1.27 times that found with the lining removed. When the ionization was due partly to scattered radiation the apparent transmission of the filter was decreased by inserting the lining. The unlined electroscope in this case gave a transmission figure for a lead filter 6.0 cm. thick which was 1.39 times that found when the electroscope was lined. H. K. M.

Electro-deposition of Rubber. ANON. *Nature*, **119**, 129–30 (Jan. 22, 1927).—The importance of the recent developments in this field arises from the discovery made independently in 1922–3 by Klein in Hungary and Sheppard and Eberlin in the United States that all the ingredients essential to the production of finished rubber articles, namely, the sulfur required for vulcanization purposes, many fillers and other compounding ingredients as well as organic dyes and vulcanization accelerators, can be admixed in a finely divided state with rubber latex or even an artificial dispersion of rubber and the whole adsorption compound produced will migrate under the influence of the electric current and be precipitated as a homogeneous layer on the anode which serves as a mold. The process is capable of many modifications and when the technic has been perfected a reduction in the cost of manufacture of sheet rubber goods and rubber fabrics may be anticipated. H. K. M.

The Cleaning and Restoration of Museum Objects. ALEXANDER SCOTT. *Analyst*, **52**, 81–2 (Feb., 1927).—An abstract on this subject from the Third Report upon Investigations Conducted at the British Museum. Discolored pictures and prints are best cleaned by the cautious use of bleaching powder and dilute HCl. Ethereal solutions of H_2O_2 are

also effective. Pyridine is recommended for the removal of varnish. Thymol is effective as a sterilizing agent. Silver is best cleaned by the use of various concentrations of formic acid, hot or cold. Iron objects, thinly coated with the oxide, are cleaned by boiling with dilute $SnCl_2$, kept faintly acid with HCl. The free acid attacks the oxide forming ferric chloride, which is reduced to ferrous chloride and does not attack iron as ferric chloride does. Lead is cleaned by the application of dilute solutions of nitric, hydrochloric or sulfuric acids, followed by thorough washing. Treatment of wood with sodium silicate has given promising results. To prevent shrinkage, glycerine and gelatin, subsequently hardened in formalin solution, have been found serviceable. Loss of brilliance in old glass is due frequently to the presence of excess alkali absorbing water and CO_2 from the air. This alkaline liquid then attacks the transparent silicates. Treatment with dilute H_2SO_4 frequently restores the original transparency. Paintings on cloth may be strengthened by the application of a solution of cellulose acetate in acetone. D. C. L.

Manufacture and Uses of Titanium Pigment. R. H. MONK. *Can. Chem. Met.*, **11**, 69 (March, 1927).—The process of obtaining titanium from the ilmenite ores is outlined. The ore containing 32% titanium oxide and 42% iron is heated with carbon, producing metallic iron, and leaving the TiO_2 unreduced. About 90% of the iron is removed by extraction with ferric chloride. The residue containing 60–75% TiO_2 is treated with a special mixture of acid sulfates at a temperature below fusion, forming soluble sulfates. On dissolving in cold water, the iron titanic sulfate is hydrolyzed, forming TiO_2. On adding $BaCO_3$, a white barium titanate of great opacity is produced. Tests indicate greater opacity than that of any other known white pigment and greater covering capacity than most others. The cost is comparable with that of zinc white or white lead. D. C. L.

The Contact Process for Sulfuric Acid and Its Application to Waste Sulfur Dioxide Gases. W. H. DE BLOIS. *Can. Chem. Met.*, **11**, 57–62 (March, 1927).—A brief historical account of the development of sulfuric acid manufacture from the time when it sold for about $1000 per ton up to the present. The utilization of the waste SO_2 from the smelting of nickel ores is discussed. In the Sudbury district 500 tons of sulfur per day are discharged into the air as SO_2, equivalent to 1500 tons of sulfuric acid, a very small proportion of which is recovered by a plant recently erected. Canadian consumption of sulfuric acid is only 200 tons daily. By the use of waste gases, the acid can be produced at a cost less than that in the U. S. D. C. L.

The Flocculation of Troublesome Precipitates in Analysis. WM. CLAYTON. *Analyst*, **52**, 76 (Feb., 1927).—In general, proper regulation of temperature, time of standing, removal of peptizing agents, and adequate electrolyte content favor the formation of coarse, easily filtered precipitates. Another method found very efficient consists in the addition of a small amount of starch solution to the finely divided suspension which produces immediate flocculation. Such diverse systems as $CaCO_3$ in saturated NaCl solution, talc and clay suspensions in water, in strongly acid or alkaline media, and numerous other troublesome precipitates, respond immediately to the addition of starch giving coarse, flocculent precipitates. The starch is adsorbed by and appears in the dried precipitate to the extent of 1 part in 250, but since the ash is very low, no appreciable errors are introduced. Normally organic colloids protect suspended matter against flocculation by electrolytes, but if the protective colloid is present in minute amounts the system is often rendered more sensitive to the action of electrolytes. D. C. L.

Corrosion of Tin Plate in Tin Cans. C. L. MANTELL AND E. S. LINCOLN. *Can. Chem. Met.*, **11**, 29 (Feb., 1927).—Three different types of corrosion are recognized; discoloration or darkening of bright metal inside container; perforation resulting in the formation of holes in the can; and solution, the result of chemical action of the food on the container. Many food products, especially legumes, contain sulfoproteins, which during canning may form hydrogen sulfide or related products. The order of some of the common metals arranged in accordance with their ease of formation of the sulfide is Mn, Cu, Ni, Fe, Sn, Zn, and Pb. The iron sulfide forms more readily than tin, so if the iron is exposed due to imperfections in manufacture, iron sulfide forms in larger amounts. Tests carried out in glass containers with strips of pure tin scattered through the canned legumes, showed that stannous sulfide is formed after several months' storage. Dilute organic acids such as 5% tartaric do not attack tin in the absence of air, but in air the oxide and tartarate are formed. 0.01 *N* citric, malic, acetic, and lactic acids attack tin in the air, less slowly in absence of air. Most neutral salts have little effect, but nitrates act as positive catalysts.

If the iron is exposed and an electrolyte is present in solution an e. m. f. of several

millivolts will be set up. The voltage rises to a peak value, fades off, and then rises to a peak value in the other direction. This occurs only in the presence of strong electrolytes. The reversal of potential indicates that the iron has been passivated, becoming less active than tin. Corn, peas, and beans show reversed potentials. The p_H of most canned goods is below 7, indicating acidity. While tin will be etched slowly, there is not much action if none of the iron is exposed. Tin salts are not harmful to the human system, and are not cumulative in metabolism. While tin has numerous defects, no suitable substitute is available. Lacquering and enameling eliminate discoloration and etching; perforation is accelerated. D. C. L.

How Genius Works. E. E. SLOSSON. *Nebr. Educ. J.*, **6**, 530 (1926).—There are two theories of genius: hard work, infinite capacity for taking pains; or great achievement through "bright ideas" which come "in moments of relaxation." A combination of the two kinds of ability in one individual makes him a true man of genius.

Science is cited as an illustration of the creative product of genius. It represents patient, persistent labor but it has also profited much from the individual with vision. And, perhaps, the vision has come in a flash like the inspiration of author or artist. In general, this revelation succeeds a period of intense and anxious thought on the problem to be solved.

In making a scientific discovery there is a period devoted to survey and amassing material followed by a flash of insight into the solution of the problem, again followed by laborious study to develop and verify the hypothesis.

The world has witnessed the fact that many of its generalizations and hypotheses were proposed by individuals scarcely out of their teens. Newton and Einstein were cited as illustrations. The suggestion is made that special facilities be provided so that students of unusual promise might advance more rapidly without waiting for slower classmates. "To give one young man of this sort the peculiar training he needs will benefit the world more than the education of a whole college full of the ordinary caliber." B. C. H.

Status of the Examiner. EDITORIAL. *School*, **38**, 212 (1926).—How may examinations be most fairly conducted? This has been a problem before the administrators of New York City schools for many years. Their recent findings may be of more than local interest. The outcome of committee conferences is:

1. There should be an executive officer, a responsible head with power to act when decision is needed. The committee names the city superintendent for such a position.
2. All papers submitted by those examined are to be read twice.
3. Oral examinations are to precede the written tests.
4. Every effort should be made to hold up the respect of those examined both for the examiners and the system back of the examiners. B. C. H.

School Safety Campaign. EDITORIAL. *School*, **38**, 196 (1926).—Is there a special need for "safety first" education with chemistry students? There should be such if the toll, even in a large city system, becomes three deaths every two days as has been the case for New York school children victimized by auto traffic. A total of forty-two were killed and 1124 were injured during the month of October. Among the causes of these accidents are listed: "Jaywalking," stealing rides, coasting upon toy vehicles, careless bicycling, skating in the roadway, and playing in the streets. Needless to say New York City school administrators and teachers are putting on a campaign of education to reduce, if not prevent, a repetition of October's record. B. C. H.

Developing the Gifted Student. EDITORIAL. *School*, **38**, 230 (1926).—W. E. Wickenden says, "The engineering colleges provide a most effective form of education for poor and mediocre students but fail to distinguish sufficiently between the really gifted man and the super-plugger." He declares the method now in general use is turning "engineering education into an elaborate and efficient scheme of secondary education."

Four suggestions are offered to improve the conditions: Organization of the laboratory squads upon a vertical plan instead of the present horizontal plan; increase of the educational value of examinations; creation of a tutorical division of instruction; and the creation of an honors course for highly selected students.

To better serve gifted students and to increase the chances for getting such students, the Massachusetts Institute of Technology has adopted two rulings: First, only students recommended by some graduate of that institution will be received; and second, thirty-six outstanding men will be chosen for their ability and achievement, and be given special opportunities to develop themselves. B. C. H.

Chemists of 1976. ELLWOOD HENDRICK. *Chem. Bull.*, **13**, 295 (1926).—"What kind of a position will the chemist occupy in industry in 1976?" asks Hendrick. Will

he be classed as a necessary, but unwelcome, expense by industry and become a routine slave, isolated from the social world or will he be a social being, living in distinction and enjoying his leisure among the gracious pursuits of life? The writer believes there is danger that chemists of 1976 may not reach the highest estate possible for them to enjoy, owing to the growing tendency of specialization in education. The student of chemistry arranges his courses too often with only his professional career in view, thus failing to provide for ripeness in general scholarship. The author suggests that the chemist depart from the constant, strict attention to business and devote some of his time to the cultivation of fine arts, so as to gain a general education which will enable him to hold a place of distinction. The chemist must be able to speak the language of the people. There is danger that he will be unable to make an exposition of the subject comprehensible to his auditors if he follows the line of specialization too closely. He must know other than technical terms. The chemist of 1976 must be patient, constantly curious, and be able to see beyond the knowledge and understanding of his day and then develop his ideas. The hope is that the chemist achieve the cachet of high intelligence and hold the reputation for superior mentality which was enjoyed a century ago by the clergy, and today by the body of men engaged in law. He must be able to go beyond its academic and industrial phases so that the great intelligentsia of every nation will sense the true bearing of chemistry on knowledge and understanding, and on human advancement.

Then will the chemists of 1976 speak with authority and become leaders of men.

E. L. MATTISON

What Price Education? ANON. *Mid. West Sch. Rev.*, **19**, 7 (1926).—The nation's expenditure for spectacular sports makes the outlay for education look insignificant when one considers that the World Baseball Series approached a million and a quarter gate receipts; and our last big prize fight over two million for a two-man combat that lasted a total of thirty-nine minutes. We spend but a billion and a half annually to train twenty-three million boys and girls for a fight that lasts an average of approximately thirty-nine *years*.

In 1892 a certain newspaper printed seven columns in the two weeks previous to the Corbett-Sullivan fight; in 1923 the same paper in a like period printed thirty-eight columns previous to the Dempsey-Firpo battle; and for the 1926 Dempsey-Tunney combat the same paper used ninety columns in the same period. Has education gained a correspondingly increased emphasis?

B. C. H.

The Excited States of Atoms. KARL T. COMPTON. *Sci. Am.*, **82**, 330–1 (Nov., 1926).—A short but interesting article on the study of the structure of the atom by spectrum analysis. The state of the hydrogen atom is disturbed which causes a change in distance between electron and proton, and results in a loss of energy which radiates off as light.

The article concludes with an illustration of photocatalysis, a piece of work done by Prof. Taylor of Princeton University. Hydrogen and oxygen gases mixed with mercury vapor, in the presence of the mercury arc, form hydrogen peroxide.

W. G. K.

Building Blocks of the Universe. B. S. HOPKINS. *Sci. Am.*, **83**, 87–9 (Feb., 1927).—Monazite from India and Brazil, a complicated mixture of salts of the rare earths, is subjected to fractional crystallization of its bromates in order to produce the new element Illinium (No. 61). In H. G. J. Moseley's spectrum analysis apparatus, the new element is bombarded with X-rays, producing rays of wave-length different from those of its neighbors.

Ninety of the ninety-two elements are known, numbers 85 and 87 being the missing ones.

W. G. K.

Simplest Atom of All. H. S. TAYLOR. *Sci. Am.*, **83**, 162–3 (Mar., 1927).—Atomic hydrogen, more familiar as "nascent hydrogen," is produced by allowing molecular hydrogen at low pressures to come in contact with a tungsten filament at the high temperature of the incandescent lamp. Great energy is absorbed by the atomic hydrogen, for the temperature attained by the recombustion of the hydrogen atom exceeds that of the oxy-acetylene flame.

Another method to produce atomic hydrogen is to have mercury atoms excited by light to collide with the hydrogen molecules. Atomic hydrogen with oxygen forms hydrogen peroxide; with carbon monoxide it forms formaldehyde. In manufacturing substances such as ammonia and crisco, it is believed the metal used as a catalyst dissociates the hydrogen into atoms.

W. G. K.

Solidification of Helium. ANON. *Sci. Am.*, **83**, 85 (Feb., 1927).—Picture of Prof. W. H. Keesom (Univ. of Leyden, Holland) and his apparatus used to solidify

helium at 150 atmospheres pressure and its boiling point. This is the lowest temperature ever attained. W. G. K.

Types of Examinations. AVERY W. SKINNER. *Am. Ed. Digest*, **46**, 248 (Feb., 1926).—Educational measurements cannot be regarded as a substitute for ordinary examinations, because examinations compel the pupil to see the whole course or subject at one time and so to see the relationships between parts; to hold a quantity of information at one time; to find out all about some matter, keep it in his head till a decision is reached and then dismiss it, as will be required of him in later life.

To accomplish best results examinations must reasonably survey the field under examination; be adapted to the mentality of the pupil and to the methods of instruction; be capable of accurate and rapid scoring and establish comparable measures of accomplishments.

New tests have been evolved in part out of careful experimentation and in part out of the modern craze to offer something different. Some are results of scholarly thought; others mere educational patter. In some, the student's knowledge of the subject is thoroughly searched; in others a certain degree of mental agility is tested. Many test memory rather than power, encourage guessing rather than exact knowledge, and are highly mechanical. The "false-true" type is dangerous unless prepared with great care and recognizing honest differences of opinion. The "best-answer" type is on the whole the most satisfactory for it calls for the exercise of judgment as well as a knowledge of subject-matter.

The better forms of new type examinations do not allow preconceived opinions to enter into judgment; are better as a means of grading pupils accurately within a group; are fairer for pupils of foreign environment and provide a battery of rapid fire questions for review purposes.

The essay type with all its limitations tests the student's ability to organize a mass of knowledge and present it clearly and logically in narrative or expository form.

The ideal examination would evaluate both knowledge and power. The first part to be of the new form and test factual mastery, the second part to test ability to interpret facts and through correct reasoning arrive at a logical conclusion. J. W. H.

The Relation of Intercollegiate Football to the Purpose of the American College. ERNEST H. WILKINS. *Sch. and Soc.*, **25**, 147–53 (Feb. 5, 1927).—An address delivered at the annual meeting of the National Collegiate Athletic Association, New York, Dec. 30, 1926, in which Mr. Wilkins sets the disadvantages of intercollegiate football to the 98 per cent of the students up against the advantages derived by the 2 per cent who actually participate in the game.

"The purpose of the American college is to train its students in body, mind, and spirit in such a way as to make them efficient leaders for human society." It is with the college students of today that America's future rests. According to Committee G of the American Association of University Professors, there are many ways in which intercollegiate football aids in the training of students, among which are—the recreation it affords; the sense of common interest; and the clean and interesting topic of conversation and thought it offers during the football season. Mr. Wilkins is of the opinion, however, that intercollegiate football interferes to an intolerable degree with the attainment of the purpose of the American college. He points out that over-excitement; the distortion of the student mind of the normal scale of values of college work and of life; the drinking which precedes and follows most games, particularly those away from home; the betting; and the surreptitious maintenance of the players, all have a detrimental effect.

Because the different remedial plans proposed give no promise of an effective cure for the greater evils the game causes, Mr. Wilkins urges the Association he is addressing, to "cure the unhealthy condition which not only menaces the future of the main intercollegiate sport, but which is interfering seriously with the endeavor of the American college to achieve the purpose for which it exists." K. S. H.

How Shall We Instruct the College Freshman in the Use of the Library? A. I. ENGLISH. *Sch. and Soc.*, **24**, 779–85 (1926).—"It is my belief that every college should offer and require some kind of training in the use of the library... that this training should begin with the freshman year." Replies are given to the questionnaires sent by Miss English to over one hundred colleges throughout the United States, in an attempt to determine what was being done toward training students to use the libraries, or how much training they had in this direction upon entering college. Apparently, she states, the high and preparatory schools are doing little to familiarize students with the use of the library, and consequently few derive, even in small measure, the culture and knowledge which is theirs through reading. Miss English urges that an attempt be made by

college librarians to instruct students in the practical use of a library that fewer may go through college and out into the world knowing little or nothing of the thousands of books which constitute our storehouses of knowledge. K. S. H.

The Scientific Study of the Curriculum. OTIS W. CALDWELL. *Sch. and Soc.*, **25**, 117–24 (Jan. 29, 1927).—An exposition of the scientific method as applied to curricular revision. Discusses the terms research and scientific method as used by educators; some fundamental principles of accuracy and the progressive nature of truth; the relation of truth to the natural sciences and other fields, with illustrations of curricular study; and the training of investigators for curricular research. K. S. H.

A Laboratory Course in Straight Thinking. GLADYS M. GRAHAM. *Sch. and Soc.*, **24**, 658–62 (Nov. 27, 1926).—The purpose of education should be to fit a student for clear and independent thinking. Due to faulty methodology, however, education in the past has fallen short in this respect. Formerly, courses in logic were considered impractical, but it is the opinion of the author that applied logic may be so taught as to furnish students with a technic for clear thinking. She tells of her experience with a group of students who were given a course of this type. They were required to gather, for class use, examples of different types of reasoning and were trained to pay critical attention to the examples read and to evaluate them. While attending other lectures and classes they continually sought for different types of reasoning, using these as subjects for class discussion.

As work of this type leads to habitual clear thinking and proves invaluable, a course of this kind might effectively be combined with the present orientation courses. K. S. H.

The Columbus of the Pacific. J. R. HILDEBRAND. *Natl. Geographic*, **51**, 85–132 (1927).—An exceedingly well-told account of the explorations of Captain James Cook, especially in the southern Pacific. From the chemical standpoint the voyages are interesting because of Capt. Cook's success in his efforts to maintain the health of his crew.

To conserve the health of his sailors upon such long journeys by sea was no easy matter, however. Upon his first voyage he sentenced a marine and a sailor at Madeira to twelve lashes each for refusing to eat fresh meat, onions and fruits he bought for them. While only these two rebelled, all his crew protested. "Indeed, they grumbled their way around the Horn and across the broad Pacific." He fed them sauerkraut, coconut milk, and even grasses. How successful he was in his fight against scurvy is attested by the fact that in the almost three years of his first voyage, he "had not lost a single life by sickness." "When he arrived in England his conquest of scurvy was acclaimed as one of his principal achievements." B. C. H.

"Cultural Morass." GLENN FRANK. *J. Educ.*, **105**, 150 (Feb., 1927).—A spirited protest against specialization in the curriculum. "All universities today are running away from the vast load of rapidly increasing unrelated knowledge, and in the elective system are taking a coward's refuge in unrelated specialization," states Dr. Frank. He further avers that it is turning universities into intellectual department stores, specialty shops, and cafeterias. Usually considered the foe to culture and the friend of science, specialization holds dangers for both. It may be conceived that scientific workers of the future may have narrower and narrower outlooks, incapable of those broad flights of the imagination which have made every epochal advance in science. There is a demand for synthesis, when analysis has shattered the world's knowledge into unrelated bits. Some first-rate educators must be found who will refuse to be awed by the bulk of modern knowledge and will be tentatively dogmatic in coherently organizing some body of general knowledge. Students must be introduced to the broad ideas of knowledge or they become provincials. A. P. B.

A Preliminary Report on the Progress and Encouragement of Science Instruction in American Colleges and Universities 1912–22. N. M. GRIER. *Sch. Sci. and Math.*, **26**, 931–40 (Dec., 1926).—Author has obtained data on enrolment in the sciences from institutions in all sections of U. S. and from this data has computed tables of gain and loss, per cent enrolment, and in connection with financial data also obtained cost per student.

Tables show decline in enrolment in majority of institutions in astronomy, biological sciences (including botany, zoölogy, and physics hygiene), and geological sciences (including physical and historical geology and physics) and an increase in chemical sciences, general physics, and general biology. It further appears that, although the first year of these sciences is becoming more popular with students, yet the department fails to hold them for advanced work in them. The decreases and increases noted above appear to parallel similar decreases or increases in secondary schools. Appropriations

for supplies and equipment, only, per student ranges from $4.20 in a Southern institution to $33.28 in a Northern Women's College with an average for 20 institutions of $12.68. Of the 20 institutions, 7 were above average appropriation and 13 were below, 6 of those above the average showing a gain in yearly appropriation per student and 1 showing a loss. Nine of those institutions below the average appropriation showed a gain in annual appropriation and 4 a loss. The average cost per student for apparatus and equipment as shown by this study in the sciences listed follows: all biology $6.36, all physics $10.98, all chemistry $12.68, all geology $6.23, and all astronomy $5.00. B. H. B.

A Study of the Vocabulary of Scientific Articles Appearing in Daily Newspapers. FRANCIS D. CURTIS. *Sch. Sci. and Math.*, **26**, 982–8 (Dec., 1926).—A previous study of 630 scientific articles to determine the percentage of terms used and distribution found in Thorndike's "Ten Thousand Words" reveals the fact that only 35.1 per cent of the terms employed were found in Thorndike's list; ranging from 4.5 per cent for the first thousand to 0.21 per cent for the sixth thousand and averaging 3.5 for each thousand as given in "The Teacher's Word Book." This analysis emphasized the fact that "the addition to a child's reading vocabulary of each thousand of the most frequently occurring words does not add greatly to the equipment for an intelligent reading of science in the public press and that vocabulary building based upon "The Teacher's Word Book" does not in itself promise to provide adequately for the needs of pupils in science—further, that the range of scientific vocabulary found in the public press does emphasize the need for extensive training in science as a foundation for an intelligent reading of the newspapers.

Therefore, the same 630 articles were used to discover (1) what percentage of the total vocabulary are common English words, (2) what percentage are scientific terms, and (3) what percentage of the uncommon words are scientific terms. Results obtained indicate that size of circulation or national importance has no relation to per cent of scientific terms.

Percentages found are:

Scientific terms in total vocabulary, 4.2 per cent
Uncommon words in total vocabulary, 3.6 per cent
Scientific terms in uncommon words, 32.7 per cent

A considerable degree of uniformity prevails in the respective percentages. A study of Radio Sections gave percentages somewhat higher: scientific terms 9.5 per cent, uncommon words 3.4 per cent, scientific terms in uncommon words 75.8 per cent.

Author concludes that Thorndike's list is a sensible first step but that specific drill and training in scientific connotations is necessary for students to obtain the meaning of science articles appearing in newspapers. B. H. B.

Report of the Committee on Chemistry. Assoc. of Science Teachers of the Middle States and Maryland, Nov. 27, 1926. *Sch. Sci. and Math.*, **27**, 183–9 (Feb., 1927).—A statement presenting the aims of the committee, desirable scientific objectives, and a syllabus for chemistry together with a bibliography. B. H. B.

A Study of Chemistry Examination Questions Given by Various States and Cities in the Middle West and East. EDITH GARNER. *Sch. Sci. and Math.*, **27**, 140–3 (Feb., 1927).—Author examined 33 different examination papers in which the number of questions ranged from 5 to 15, and totaled 382. Questions were classified under seven headings as follows:

1. Problems, 51 questions or 13.32 per cent of total
2. Commercial and industrial chemistry, 59 questions or 15.4 per cent
3. Memory Tests (terms, etc.), 91 questions or 23.8 per cent
4. Laboratory, 68 questions or 17.8 per cent
5. Use of Symbols, Formulas, etc., 70 questions or 18.32 per cent
6. General Discussions, 29 questions or 7.5 per cent
7. Miscellaneous, 14 questions or 3.6 per cent.

Each main heading was then subdivided and cases tabulated.

Author notes that from such a study of examination questions a fairly good idea of the chemistry being taught can be obtained, probably quite as well as from questionnaires. B. H. B.

Free and Inexpensive Science Equipment. DUANE ROLLER. *Sch. Sci. and Math.*, **27**, 34–9 (Jan., 1927).—A discussion of material that may be obtained for science work from manufacturers, government agencies, educational institutions, etc., in the form of catalogs, descriptive pamphlets, samples, models, slides (rental or free), and other forms. B. H. B.

Local Activities and Opportunities

Princeton University. After the winter meeting of the Board of Trustees of the University it was announced that Dr. Edward Plaut, class of 1912, and President of Lehn and Fink Products Company, Inc., had established a fellowship in chemistry in memory of his father. It will, therefore, be known as the Albert Plaut Fellowship in Chemistry, and will pay an annual stipend of $750.00.

A year's course on the Chemistry of the Metals and Qualitative Analysis is being offered to a score of freshmen who were selected because they passed chemistry for entrance with high grades and had made exceptional school records. Professor H. S. Taylor, chairman of the department, is in charge of the course. These selected men are, therefore, given the benefit of his ability as a teacher and his enthusiasm for pioneer work. Provision has been made to offer these men exceptional opportunities in their upperclass years.

Mr. H. N. Alyea, former Scandinavian-American Fellow has returned from Sweden where he worked with Dr. Hans Bäckström, former National Research Fellow at Princeton. Mr. Alyea continues his studies as Charlotte Elizabeth Procter Fellow in Chemistry.

Mr. S. O. Morgan has resigned the du Pont Fellowship in Chemistry to return to the Bell Telephone Laboratories, 463 West St., New York. Mr. V. C. Rogers has been appointed to the Fellowship for the balance of the year.

Dr. William Foster is the author of a new book, published by the Century Company, and entitled "The Romance of Chemistry." The appeal is to the general reader and to those interested in pandemic chemistry. In a sense the work may be said to be intermediate between the usual popular treatise and the first-year college text on chemistry. It is illustrated with stories and quotations, and contains a wealth of drawings, diagrams, and full-page halftones. Everything from the old alchemy to the new is considered. Many practical applications are treated, as the farmer's, the physician's, the housewife's and the manufacturer's dependence on chemistry. Any careful reader of the book will have acquired a fair knowledge of fundamental chemical principles, properties, and reactions.

University of Colorado. The old chemistry building of the University of Colorado has been entirely remodeled and a large wing built at each side. For a number of years the department has been badly handicapped by the over-crowded condition in the old building. It now has one of the largest and best equipped laboratories in the Rocky Mountain region. Indeed, few laboratories are better equipped for modern work in physical chemistry, microchemistry, spectrum analysis, state food work, water analysis, organic and inorganic preparations, in addition to the usual laboratories for undergraduate work. Each member of the teaching staff not only has his own office but also a private laboratory. By having all desks, tables, cases, etc., made by the engineering departments of the university the total cost of the new building and equipment was kept down to $230,000.00.

On February 19th the building was dedicated. The state legislature came to Boulder on a special train, was entertained at dinner by the Chamber of Commerce, made a tour of inspection of the building while students and instructors were at work, and attended the dedication in the evening. The presidents and chemical staffs of the other state institutions were also guests of the university.

Dr. Samuel C. Lind, dean of the school of chemistry of the University of Minnesota, gave the dedicatory address on "The Progress of Chemistry during the Past Twenty-Five Years." The keys to the building were formally presented to Dr. John B. Eckley, head of the department, by Lieutenant-Governor Corlett. A tour of inspection followed the dedication exercises.

Michigan State College. The department of chemistry of Michigan State College has a number of half-time graduate assistantships available from time to time. These assistantships carry a remuneration of $800 per year of nine months. The assistantships permit the students to devote one-half of their time to graduate work toward advanced degrees.

Three in biological chemistry (1 available in 1927–28).

One in organic chemistry (available in 1927–28).

Two in physical chemistry (electro) (available in 1927–28).

One in physical chemistry (colloid) (available in 1927–28).

Two in metallography (1 available in 1927–28).

Detailed information with respect to these assistantships and application blanks for same may be obtained by addressing Arthur J. Clark, professor of chemistry, Michigan State College, E. Lansing, Michigan.

Brown University. On March 18th the Student Chemistry Club of Brown University held its monthly meeting. At this meeting the Eagle Picher Company of Boston supplied several reels of films on "Pigs of Lead."

At the March meeting of the Rhode Island Section of the American Chemical Society, which was held on the 25th, Professor Joseph S. Chamberlain of the Massachusetts Agricultural College, lectured on "The Relation between Chemistry and Agriculture." For this meeting special invitations were sent to all the high-school teachers in the state and others interested in chemistry. It is hoped that a much closer relation may be brought about between the members of the Section and the non-members throughout the state. Mr. Charles M. Perry gave a brief account of the history of the Rhode Island Section, the first section of the American Chemical Society.

The New England Association of Chemistry Teachers held its 104th meeting at the Metcalf Laboratory, Brown University, on March 19th. Three addresses were presented:

"Objective Examinations in Chemistry," Professor Norris W. Rakestraw.

"Radiation, Its Source and Destiny," Professor Carl W. Miller.

"Some Intermetallic Compounds; An Interpretation of Their Constitution and Their Relation to Other Well-Known Substances," Professor Charles A. Kraus.

On March 2nd, Professor Arthur Haas, of the department of physics, University of Vienna, presented a lecture on "The Atom as a Source of Energy."

The Brown Chapter of the Society of Sigma Xi held its annual initiation and banquet on Tuesday, March 8th, at the Faculty Club of Brown University. The speaker was Professor H. B. Goodrich of Wesleyan University, who presented as a subject, "Conflict of Teaching and Research." The delegates present were Professor H. S. Seward of Yale University and Professor W. J. Jennings of Worcester Polytechnic Institute. Professor E. K. Strachan, Brown University, was toastmaster. From the chemistry department two students were elected to full membership; Cecil L. Brown and Earl Brown. Six graduate and three undergraduate students were elected to associate membership; William W. Hawes, W. Harlow Kahler, Ernest R. Kline, Walter Katz Nelson, Ellis F. Parmenter, Wade B. Robinson, Seebert J. Goldowsky, Loring P. Litchfield, Thomas C. Morris. The banquet was attended by 125 members of the Society.

Carnegie Institute of Technology. In coöperation with the Pittsburgh Experiment Station of the U. S. Bureau of Mines, eight research fellowships in mining and metallurgy are offered by the Carnegie Institute of Technology during the coming year. The fellowships are open to the graduates of colleges, universities and technical schools who are properly qualified to undertake research investigations.

Each fellowship carries a stipend of $750.00, paid in ten monthly instalments. The period of each fellowship will be from August 15, 1927, to June 15, 1928. The purpose of these fellowships is the solution of problems which are of special importance to the mining, metallurgical, and allied industries.

Final selection of the problems for investigation will be made later by two advisory boards of engineers, metallurgists, mine operators, and business men who are assisting in the development of the departments of mining and metallurgy at Carnegie Tech. At the conclusion of the studies, it is announced, reports will be published jointly by the Carnegie Institute of Technology, the Bureau of Mines, and the Advisory Boards. Twenty-nine of such reports have already been published since the inauguration of the present coöperative research plan in Pittsburgh.

Application blanks for fellowship appointments can be secured by writing the Secretary, Mining and Metallurgical Advisory Boards, Carnegie Institute of Technology, Pittsburgh, Pa.

A second International Conference on Bituminous Coal will be held at the Carnegie Institute of Technology in November of 1928 according to an announcement by Dr. Thomas S. Baker, president of the institution. The statement is contained in the recently issued volume of proceedings of the first conference held from November 15th to 18th, of last year.

"We are so greatly encouraged by the success of the first International Conference on Bituminous Coal held at the Carnegie Institute of Technology last year," he states, "that we have definitely decided to hold a second and similar international congress two years from now."

Courses for teachers are featured in the plans for the Summer Session this year. The course for teachers will be given for six weeks from June 27th to August 5th. Courses for undergraduates will extend eight weeks from June 13th to August 5th. The program for both groups of courses will include work in the College of Engineering, College of Industries, College of Fine Arts, and the Division of General Studies.

As in the past few years, special attention will be given to the entertainment of the students. Dances, picnics, boat rides, inspection trips, popular lectures, musical entertainment, and swimming in the pool of the new gymnasium, will constitute the main features of the social activities during the work of the session.

University of California, Southern Branch. Mr. K. A. Thomas, formerly Teaching Fellow at the University of Minnesota and Resident Chemist for the Pure Oil Company of Minnesota, is in charge of quantitative analysis at the University of California at Los Angeles during the sabbatical absence of Professor W. R. Crowell. Professor Crowell has been granted leave to carry out some investigations at the California Institute of Technology on the vapor pressure of borax and the chemistry of some of the rarer elements.

Cincinnati Section, A. C. S. The 189th regular meeting of the Cincinnati Section of the American Chemical Society was held on Thursday, March 24th, at the University of Cincinnati. This was a joint meeting with the American Society of Mechanical Engineers, the American Electroplaters' Society and the American Electrochemical Society. Mr. William

Blum of the Bureau of Standards gave a lecture on "Chromium Plating and Its Applications."

Ohio State University. Beginning April 11th, Dr. Robert Andrews Millikan delivered a course of lectures before the Graduate School of the Ohio State University, on the general theme, "Twentieth Century Discoveries in Physics."

The program of the lectures is as follows:

Monday, April 11th

8:00 P.M.—The Birth of Two Ideas

Tuesday, April 12th

4:00 P.M.—The Discovery of the Electron
8:00 P.M.—Seeing the Invisible

Wednesday, April 13th

8:00 P.M.—Gulliver's Travels in Science

Thursday, April 14th

4:00 P.M.—Light Dart
8:00 P.M.—Stripped Atoms

Friday, April 15th

4:00 P.M.—The Birth of a Light Ray
8:00 P.M.—Cosmic Rays

Saturday, April 16th

11:00 A.M.—Relativity Inside an Atom

Monday, April 18th

4:00 P.M.—Pulling Electrons Out of Metals
8:00 P.M.—Isotopes and Their Significance

Tuesday, April 19th

4:00 P.M.—Spectroscopic Prediction.

Lexington Section, A. C. S. The Lexington Section of the American Chemical Society held its 119th regular meeting at the University of Kentucky, Saturday, April 9th. The program was preceded by a dinner in honor of the guest of the Section, Dr. Neil E. Gordon of the University of Maryland. Following the dinner Dr. Gordon spoke to the Section on "The Research Institute for Chemical Education."

Georgetown University. At the meeting of the Chemistry Club of Georgetown University, February 19th, Dr. Gustav Egloff, of the Dobb's Cracking Process Company, delivered a lecture treating in general the distillation of petroleum, and more especially the advantages and saving occasioned by the cracking processes now in use.

On March 9th, Dr. M. X. Sullivan of the U. S. Hygienic Laboratory, who was the speaker of the evening, delivered a lecture on the occurrence of sulfur in the body and the rôle that the sulfur compounds in the body play in warding off disease.

On Tuesday, March 22nd, Dr. F. A. Ernst, of the Nitrogen Fixation Plant, delivered a lecture concerning the history of nitrogen fixation, enumerating the various methods in use and listing their advantages and disadvantages.

On Monday evening, March 28th, Professor Victor Clarence Vaughan, who was chosen by a committee representing the Medical Corps of the Army, Navy, Public Health Service and the American Public Health Association as the Lecturer of the Kober Foundation for 1927, was introduced by the Reverend Charles W. Lyons, S. J., President of the University, Dr. Vaughan delivered an address on "The Chemistry of Living Substances and Its Adaptability to Its Environment."

University of Florida. Mr. B. J. Otte, curator of the department of chemistry, attended the fourth annual meeting of the Pine Institute of America held in Jacksonville on February 22nd. Dr. E. R. Weidlein, director of the Mellon Institute of Industrial Research, was the chief speaker. He discussed the work being done at the Institute by the Pine Institute Fellows. Dr. Charles H. Herty spoke along the general line of naval stores. About 200 were in attendance at the meeting.

Recent Books

Laboratory Manual of Qualitative Chemical Analysis for Students of Pharmacy. THEODORE J. BRADLEY, A.M., B.S., Ph.G. Professor of Chemistry, Massachusetts College of Pharmacy. Lea & Febiger, Philadelphia. Fourth edition, 1926. vii + 184 pp. 20 × 15 cm. $2.25.

This book contains a short review of the fundamental concepts of matter and energy along with a summary of the subjects of valence, atomic weight, nomenclature, symbols, etc. The subject-matter of this section is treated as an introduction to the course in qualitative analysis proper. The tests for the metallic ions are studied in the usual group method of qualitative procedure. These are followed by a systematic scheme for the detection of the anions including a guide for the treatment of unknown specimens and certain tests peculiar to the Pharmacopoeia.

The outstanding characteristics of this treatise seem to be its simplicity of style and arrangement, in addition to provisions for the development of self-reliance on the part of the student by giving him the opportunity to complete equations in the text proper. The procedures outlined for the analysis of unknown specimens are concise and sufficiently adequate for a course in applied chemistry. The tests incorporated from the Pharmacopoeia have been well chosen, although the reviewer feels that following each test, the equation and an explanation regarding the test would be helpful to the student.

Although this book is intended solely for students of pharmacy, it seems to the reviewer that the inclusion of a discussion of the solubility product principle and common ion effect would be a valuable addition from the point of view of chemical education.

J. C. KRANTZ, JR.

A Textbook of Organic Chemistry. JULIUS SCHMIDT, Stuttgart. English translation by H. Gordon Rule, Edinburgh. D. Van Nostrand Co., New York, 1926. xxiv + 798 pp. 16 × 24 cm. $9.00.

This is a book suitable either as an occasional reference book for a class in elementary organic chemistry or as a textbook for an advanced class. It fills the place which would be occupied by an English translation of Richter's "Organic Chemistry," if a good one were available.

All the important divisions of organic chemistry are treated in a very excellent manner. The chapters on the carbohydrates, purines, terpenes, heterocyclic compounds, and chlorophyll are unusually good. The treatment of such subjects as desmotropy, free radicals, and naturally occurring drugs and dyes leaves nothing to be desired.

The only glaring fault which occurs to an American user of the book is in the treatment of petroleum and related subjects including cracking. It is stated, for instance, that the most important places in which petroleum occurs are Pennsylvania in North America and the region around Baku in Caucasia.

A future edition might be improved by taking into consideration developments in organic chemistry which have taken place outside of Germany. To cite only the simplest substances involved, we could list methane, methylene chloride, chloroform, products obtainable from ethylene such as the chlorohydrin, the glycol, and esters and ethers, the newer commercial alcohols such as isopropyl, *n*-butyl, secondary butyl, and tertiary butyl, and ketene and urea. The only development of this kind which is considered in the present edition is the commercial prepara-

tion of acetaldehyde and acetic acid from acetylene.

It is impossible for the reviewer to express anything but admiration for this work because of its very complete and remarkably well-balanced treatment of almost all of the phases of our knowledge of organic chemistry.

FRANK C. WHITMORE

Catalysis in Theory and Practice. E. K. RIDEAL AND H. S. TAYLOR. Macmillan and Co., Ltd., New York City. Second edition, 1926. xv + 516 pp. 13.5 × 21.5 cm. $6.00 net.

Any user of the first edition of this important work knows intuitively that he must have a copy of the second edition. The rapid advances in our knowledge of catalysis since 1919 insure that the new edition cannot help but be greatly improved.

Drs. Rideal and Taylor have taken full advantage of their opportunity. The whole work has been completely revised, rearranged, and expanded. Three chapters have been added and the text of the book enlarged altogether by about thirty-five per cent. Although only twenty pages have been added, this has become possible through the use of smaller type. Chapters II—Theoretical Introduction—and III—The Measurement of Reaction Velocity in Catalytic Processes—of the older edition have been expanded so as to cover Chapters II to VI in this edition. The titles of these chapters are Criteria of Catalysis; Homogeneous Reactions; The Theory of Heterogeneous Catalytic Reactions; Promoters; Mixed, Supported, and Protected Catalysts; Catalyst Poisons; and the Inhibition of Homogeneous Chemical Reactions.

This serves to show where the growth of our knowledge of catalysis has occurred. The theoretical part of the book has, in consequence, been enormously improved. The concept of active molecules and related topics has been expanded from three to twenty pages, the properties and behavior of solid catalytic agents from ten to thirty-two pages, and negative catalysis from one and one-half to fifteen pages. There is a section showing the correlation of the data of catalysis with the thermodynamic properties of solutions, a section discussing the structure and probable mode of formation of unstable complexes, and a section going very thoroughly into the subject of promoters and promoter action.

But it is not the theoretical part alone that shows improvement. Many new processes are recorded and described. Notable among these are the new processes for synthetic methanol and for synthetic motor fuels. The Claude, high-pressure process for nitrogen fixation is discussed. The chapter on Catalysis by Radiant Energy has been expanded fifty per cent.

The book is replete with references. Although the authors disclaim any attempt at bibliography compilation, one cannot help but feel that they have included enough. The paper, binding and printing are a decided improvement over the first edition. Catalysis in Theory and Practice is without doubt destined to stimulate very greatly our interest in and investigation of that subject.

MALCOLM M. HARING

Equilibria in Saturated Salt Solutions. W. C. BLASDALE. A. C. S. Monograph Series. The Chemical Catalog Co., Inc., New York City, 1927. 197 pp. 15 × 22.5 cm. $4.50 net.

This book is a summary of studies made over a long period of years by many people on saturated aqueous salt solutions. It does not attempt to cover all the data available, nor is it a compendium of literature references. Only the more important systems are considered. Nevertheless it should prove an invaluable aid to every worker in this field.

Although this monograph covers all types of salt solutions from 2 to 6 components, its greatest value lies in the treatment

of 3, 4, 5, and 6 component systems. This is really excellent. The discussion of P–T diagrams for binary salt solutions is very good and more extensive than one usually finds in the standard works on the phase rule. One wonders why the first chapter on the system water is included at all. Use of Dr. Blasdale's work presupposes a thorough knowledge of the first principles of phase theory, and this chapter does not seem to add to it.

Especially commendable are the very thorough discussions of the various graphical methods in use to represent polycomponent systems; the excellent review of the problem of the Stassfurt salt deposits; and the many illustrations of the calculations of heterogeneous equilibrium. For example, there is a discussion of the use of phase diagrams in quantitative calculations, of quantitative calculations on four component systems, and of the changes occurring during the evaporation of sea water.

On page 47, Abbegg should be changed to Abegg, and on pages 50, 52 and 53, the correct reference is Carpenter and Jette rather than Carpenter and Jelle. The equilibrium signs on page 50 and elsewhere should be $\rightleftarrows$ rather than $\longrightarrow$. Aside from these points, the cuts, binding, printing, etc., are done in the excellent style of the other A. C. S. monographs. Altogether Dr. Blasdale is to be congratulated on his contribution to this valuable series.

MALCOLM M. HARING

Physico-Chemical Metamorphosis, and Some Problems in Piezo-Chemistry. ERNST COHEN. McGraw-Hill Book Company, Inc., New York City, 1926. 190 pp. 15 × 23 cm. $2.50.

Dr. Ernst Cohen, University of Utrecht, is well-known in the United States not only through his great professional and scientific reputation but also because of the charm of his personality and his ability to entertain his audiences. It is, therefore, with a great deal of pleasure that we see the publication of Dr. Cohen's lectures at Cornell University.

These lectures cover two subjects, one, physico-chemical metamorphosis, and the other piezo-chemistry. The text was originally written by Dr. Cohen in German and has been admirably translated into English by Dr. L. F. Audreith.

Dr. Cohen in the first half of his book brings out clearly an unappreciated fact; to wit, that most solid substances, elements, or compounds are capable of existing in two or more physical forms. This is brought out by numerous experimental investigations on various substances by the author and his co-workers. As he states, the importance of this fact is considerable if one takes into consideration that each physical type has its own physical properties and, therefore, many of the physical measurements whose results are shown in the handbooks and in the general literature are highly in error because they fail to state which physical form was tested. Discrepancies in reported results of physical measurements may be largely attributed to this cause. Not only is it possible that separate investigators used different physical types of the same substance but it is also probable that may of them worked with mixtures rather than with single pure physical types.

The reviewer would like to point out that it is quite possible that future generations of Cohens will discover that each physical form is capable of being separated into sub-physical forms which we will call for the moment "isotopes." For example, the alpha form of cadmium iodide will be found to have 42 sub-physical "isotopes" and after ten years of experimentation it will be possible to separate only one of the 42, number 23, in concentrations up to about 40%. In other words, without wishing to appear factitious, the broad idea of subdivision will go on indefinitely and from a philosophic standpoint there is no limit. Dr. Cohen, however, should be congratulated on his clear and fascinating

presentation of this very worthwhile subject.

The second half of the book is concerned with piezo-chemistry, or the influence of very high pressures on volume, solubility, etc. The reviewer was not so much interested in this subject because the parts which were easily digestible were the experiments run to show the effect of pressure and comparison of this effect with the calculated effect obtained by the utilization of some thermodynamic equation such as the Clapeyron-Clausius equation. The results agreed very nicely with the calculations as would be expected. The apparatus used, however, was most ingenious and it is easily seen how a student would thoroughly enjoy himself in this line of investigation if he had the opportunity to work in Dr. Cohen's laboratory and use this very elaborate and very interesting apparatus.

The entire book is given over to two fields of specialized research but it is, nevertheless, both worthwhile and entertaining to the ordinary reader because the author has allowed some of his own charming personality to appear within the lines.

D. B. KEYES

Outlines of Physical Chemistry. GEORGE SENTER. Principal and Head of the Chemistry Department, Birkbeck College (University of London). D. Van Nostrand Company, New York City. 14th edition, 1926. xx + 421 pp. 9.5 × 15 cm. 46 figures. $3.00.

The first edition of this book appeared in 1908, and made a good impression at once. The reason for this was the fact that the author considered it wise to present the *general principles* of the subject, and not to stress any particular theory or slant of his own. This method of treatment was very much favored also by the fact that the book was written in a very clear and lucid style, entirely suitable for the beginner. At the time of its first appearance the writer of this review was studying for the doctorate in chemistry, and he found this little book extremely useful in making preparation for more advanced material given in lectures upon the subjects treated. The book is not intended as a reference book for the expert, but as a textbook for the beginner, who has to "build a ladder from ignorance to knowledge."

The present edition contains some material not before presented, or, at least not so well. For example, one finds something on Atomic Structure, and wishes there were more. The author could well have made this the subject of a chapter. At the end is found a list of "Problems and Questions" which is good, but which might well be extended. Problems come next to laboratory work in driving home the principles.

One of the strong points of the book has always been the "Practical Illustrations" given at the ends of the chapters. These suggest a fine line of lecture or laboratory experiments.

The press-work is good, but the binding does not seem quite so substantial as did that of the first edition.

All in all this is a fine little text which, for elementary work, would be hard to equal.

W. H. CHAPIN

Lecithin and Allied Substances: the Lipins. HUGH MACLEAN, M.D., D.Sc., AND IDA SMEDLEY MACLEAN, D.Sc., F.I.C. Longmans, Green & Co., New York City. Second edition, 1927. vii + 220 pp. 38 tables. 15.5 × 24.5 cm. $3.75.

This treatise is a new edition of one of the units of the series of "Monographs on Biochemistry" edited by R. H. A. Plimmer and F. G. Hopkins. The subject-matter of the text is substantiated by an exhaustive bibliography consisting of 655 references and is distributed under the following chapter titles:

Chapter	Subject	Page
I.	Introduction and Nomenclature	1
II.	The Chemistry of the Phospho-	

Chapter	Subject	Page
	lipins (Phosphatides), Lecithin, Kephalin, Spingomyelin	21
III.	The Occurrence, Methods of Extraction, Isolation and Purification of the Phospholipins	67
IV.	The Galactolipins (Cerebrosides) Phremosin, Kerasin, and Nervon	91
V.	Alleged Lipins—Protagon, Cuorin, Carnaubon, Paranucleo-Protagon, Jecorin, and other Insufficiently Characterized Substances	124
VI.	Plant Lipins	153
VII.	The Function of the Lipins. Lipins from the Biological Standpoint	167
Bibliography		189
Index		217

The purpose of the book, to quote from the editor's general preface, is the presentation of "full and independent information of the work which has been done upon the subject."

Without question, no pains have been spared in the effort to fulfil this purpose, not only in the selection of experimental and theoretical data, but also in the introduction of this material in a concise, straightforward style and from an unbiased standpoint.

Throughout the volume one senses an undercurrent of restlessness arising out of the exact functions of the phospholipins and galactolipins, and an appeal, manifested most markedly in Chapter VII, for added original work leading toward the development of a more definite understanding of these important cell constituents.

This monograph shares the same high standard of excellence exhibited by the other books of this series and will prove a valuable acquisition to anyone interested in biochemistry from any angle.

H. BOYD WYLIE

Three Lectures on Atomic Physics. ARNOLD SOMMERFELD, F.R.S. Professor of Theoretical Physics at the University of Munich. E. P. Dutton and Company, New York City, 1927. 70 pp. 12 × 18.5 cm. $1.00.

These lectures, delivered at the University of London, deal with recent developments of the quantum theory. Various quantum numbers are introduced and defined in the first lecture, and a new theory of the hydrogen atom is developed, according to which this atom has a structure analogous to that of the alkali metals. The second lecture is mainly mathematical. The third lecture deals with the periodic system of the elements and the tetrahedral crystal structure of certain elements of the fourth group. In this connection the problem of chemical linkage is discussed in general, with especial reference to the nature of nonpolar compounds.

The topics taken up are important and comprehensive, but the treatment is altogether too abstruse for the casual reader. Professor Sommerfeld has previously annotated some of Einstein's writings on Relativity, and the majority of chemists will undoubtedly find the argument in this volume quite as elusive as the intimate details of the new space-time theory. To the enthusiast who is prepared to grapple with any difficulties, however, the book opens up an unusually fascinating and fertile field.

JAMES KENDALL

Work Book in General Science. ELLIS C. PERSING, A.B., Department of Biology and General Science, Cleveland School of Education, and KIMBER M. PERSING, B.S., Department of Science, Glenville High School, Cleveland, Ohio. In the Harter Work Book Series, edited by Garry Cleveland Myers, Ph.D. The Harter School Supply Co., Cleveland, Ohio, 1927. 127 pp. 48 figs. 21 × 27 cm. Price, $.60.

This is a notebook for student use in general science. It contains the characteristic blank spaces for writing answers,

columns to be filled in, white areas for sketches.

There are two attitudes toward notebooks in general science—or any science, for that matter. Some teachers desire them to be the students' work in every aspect—expression, interpretation, arrangement, neatness of record. Others favor expedients that facilitate speed and convenience for the pupil, and lift some of the burden of criticism and grading from the busy teacher. The former plan recognizes individuality, the latter systematizes and organizes. This "Work Book" serves only those teachers of general science who prefer the latter plan.

(It may be pertinent to call attention to the fact that his type of notebook—space on the printed page for records—was tried out by chemistry teachers many years ago, but did not hold their favor.)

There are ninety-seven experiments, all very practical. Actual investigations around the home comprise 22 per cent of these; food and clothing 20 per cent. The three special sciences divide one-third of the material between them—biology, 14 per cent; physics, 11 per cent; chemistry, 8 per cent. Seven per cent of the experiments could be classed as hygiene.

The authors in their preliminary instructions to students have placed themselves in full accord with the true spirit of teaching general science experimentally with their statement, "...a laboratory is not necessary. Any of the problems may be worked by you in your home with very little cost for material." General science is the science of home and community; it is not a formal laboratory subject. Show us a general science teacher who is failing, and we will show you a formalist who is helpless away from the polished top of a laboratory desk.

This "Work Book" makes effective use of a library. Let the school provide eight useful reference books (or sets), some half-dozen of the better general science texts, one or two good chemistry, biology, and physics texts—the authors make suggestions as to the titles— and the pupil may supplement his first-hand investigation with the authorities. Is there any better way to study science?

We called the experiments practical. They are also seasonable. The authors have boldly broken away from the plan of several general science texts, and assign studies of sprouting seeds, growing plants and gardening in the *spring*, instead of mid-winter, where *these texts* present them. (If you don't believe this, we can show you the books!) The authors of the Work Book have slipped once: the anti-freezing mixtures should be poured in automobile radiators about November 1st instead of April 1st.

There is not much chemistry in this Work Book—a wise omission. When pupils come to chemistry teachers already possessed of *a broad foundation and a love of science*, these teachers' troubles will be nearly at an end.

H. A. WEBB

Second Year College Chemistry. A Manual of Laboratory Exercises. WILLIAM H. CHAPIN. Professor of Chemistry in Oberlin College. John Wiley and Sons, Inc., New York City. Second edition, 1927. xi + 143 pp. 26 figures. 14.5 × 23 cm. $2.00, net.

The second edition of Professor Chapin's laboratory manual has been very much improved by revisions and additions. The manual was written to accompany the author's text, "Second Year College Chemistry," and is very carefully coördinated with it so that a class in second-year college chemistry may be carrying out laboratory work in a subject at the same time that the subject is being treated theoretically in the class-room. As a result of the author's many years of experience in teaching second-year college chemistry, there are to be found in the laboratory manual 76 well-chosen and carefully tested experiments. These experiments deal with the gas laws, laws of chemical combination, laws of solution,

chemical and physical equilibria, electrochemistry and colloidal chemistry. The experiments are written in the author's usual clear and precise style. The apparatus required is simple and most of it may be assembled out of the ordinary equipment found in a college laboratory. Not only may the manual be used in connection with a course in chemistry similar to the author's second-year college chemistry but also in connection with any college course in analytical chemistry. The reviewer has frequently used many of the experiments in the laboratory part of an elementary course in physical chemistry and in an advanced section in general chemistry where they were a stimulus to some high standing students who had studied in a course in chemistry in secondary schools.

In this edition of the manual, the author has included the quantitative procedures which are given in his course, a good introductory chapter on the use of the analytical balance and on laboratory technic and at the end of the work some well-selected colloidal preparation experiments.

It is now a generally accepted pedagogical theory that if a first course in chemistry is to be a descriptive fact-finding course, the second course should be one on the use of facts to establish the great underlying principles of chemistry. If the student is able to master the principles of chemistry early in his career, he will be better able to carry the work in his upper courses in chemistry. With this guiding theory in mind, Professor Chapin has written his "Second Year College Chemistry" with its supplementary "Laboratory Manual." They are to be commended in that they do not aim to make analysts out of students in their second year but to train them in this phase of chemistry which will be of more value to them in their later work.

J. FITCH KING

New Drug Treats Both Syphilis and Leprosy. A drug that is designed to treat both syphilis and leprosy simultaneously has had a successful tryout in Calcutta, according to reports received in London. It was developed under the direction of Dr. T. A. Henry at the Wellcome Chemical Research Laboratories and consists of a mercury derivative rendered soluble in one of the complex compounds of chaulmoogra oil.

Arsenical drugs, such as are used for syphilis, are very dangerous to administer to syphilitic lepers so that some form of treatment for patients afflicted with both diseases that does not produce harmful reactions is highly desirable. Thirty lepers with syphilis were treated with the new compound by Dr. E. Muir of the School of Tropical Medicine and Hygiene in Calcutta with considerable success. After the course of treatment, sixteen showed negative Wassermann tests, two were doubtful and only eight remained strongly positive, while the whole group showed improvement as far as leprosy was concerned. The drug is said to be quite safe to administer and in none of the cases did it give rise to any undesirable symptoms.—*Science Service*

American Methanol to Compete with German. Methanol, the synthetic chemical replica of wood alcohol which for the past two or three years has figured largely in chemical imports from Germany, is now to be manufactured in America by a new and wholly American process, it is announced by E. I. du Pont de Nemours and Company. Two years of intensive research were required for the development of the new process, but officials of the company are now satisfied that it is commercially practicable, and a plant for large-quantity production has been constructed at Belle, near Charleston, W. Va., by a company affiliated with the du Pont interests. Future construction already planned is expected to take care of the entire American demand for methanol.

The process involves the use of carbon monoxide and hydrogen at high temperature and under great pressure.—*Science Service*

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